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EDITED BY
V. R. GARDNER AND A. A. APPLEGATE

CONTRIBUTIONS BY ALL SECTIONS OF THE
AGRICULTURAL EXPERIMENT STATION

MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN
Volume XXI, Number 3, February, 1939

MEASURING HYBRID CORNS FOR MICHIGAN

A. R. MARSTON
Section of Farm Crops

No method of breeding has offered the possibilities for marked improvement in the productive and physical attributes of corn as the method, now widely used throughout the United States, of mating together carefully chosen inbred lines to produce hybrid vigor.[1] However, it must be borne in mind that the term, "hybrid corn" is not merely the name of another corn variety but that it is the general term applied to a great number of corn varieties resulting from a particular method of breeding. There is just as much variation among the different hybrids as there is among the usual open-pollinated varieties.

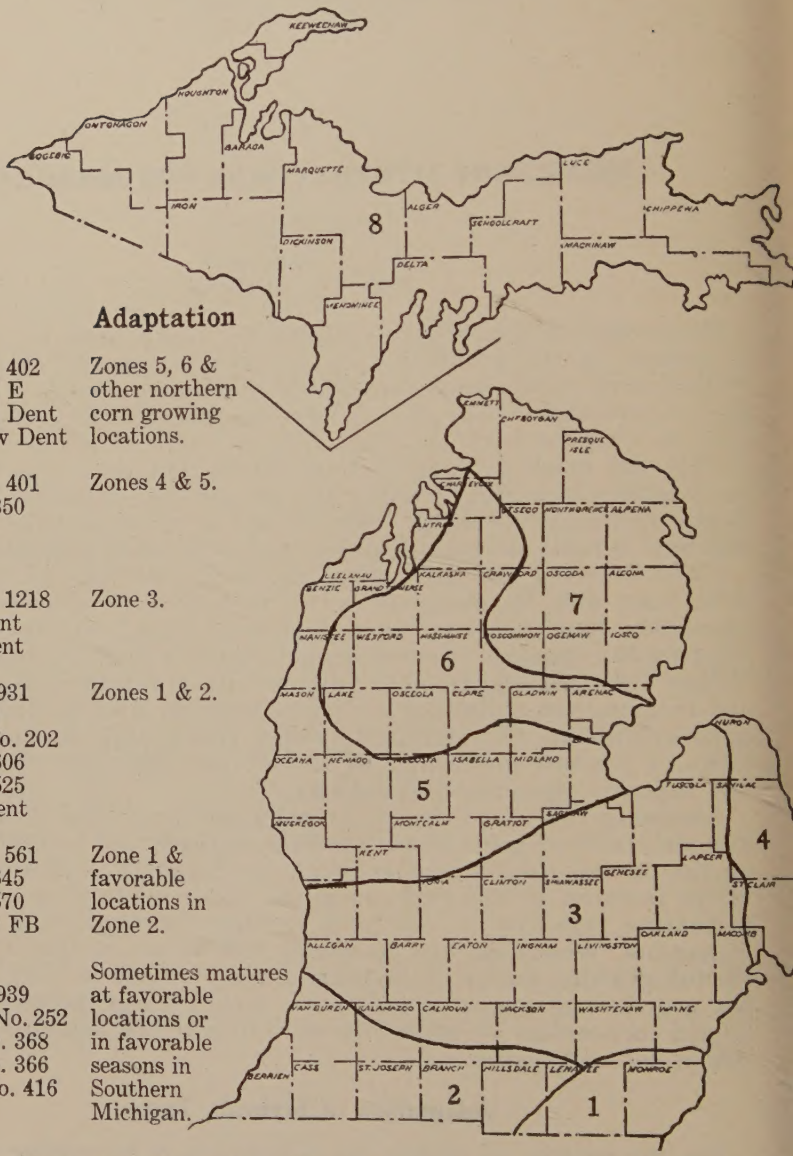
Plant breeders, in developing the different lines of hybrid corn have been able to eliminate many undesirable characteristics more effectively than was true by ordinary selection methods used in developing the standard open-pollinated varieties such as Leaming, Reid's Yellow Dent and similar corn belt varieties, or Duncan, Golden Glow, and Pickett, open-pollinated varieties commonly used in Michigan. Thus, good hybrids are characterized by stiff stalks; well developed, healthy roots; a marked uniformity of kernel, ear and plant characteristics, and superior vigor and productivity.

Assuming that most of the hybrid corns now offered commercially are the result of good plant breeding methods and careful production on the part of hybrid seed growers, these hybrids still are vastly different in value for any given location. Some hybrids are early enough to mature regularly in the most northern corn growing sections of Minnesota, Wisconsin, and Michigan; others are so late as to require the full growing season of the heart of the corn belt in Iowa and Illinois. No grower can expect superior or even average performance from hybrid corn unless he plants the seed of a hybrid adapted to his particular soil and season.

Adaptation of Hybrids Tested

For the purpose of testing the adaptation of promising hybrids developed at the Michigan Agricultural Experiment Station and to aid in evaluating hybrids developed elsewhere (many of which are offered for sale in Michigan), the Farm Crops Section has for the last four years conducted a series of over-state trials of a large number of corn hybrids. Cooperation in this work has been extended by county agricultural agents, farmers, the Michigan Crop Improvement Association,

[1]For a detailed discussion of hybrid corn, the breeding and production methods used, and the kinds of improvement which this breeding method makes possible, write to the Bulletin Room, Michigan State College for Michigan Extension Bulletin 195: "Hybrid Corn and Its Place in Michigan".



Varieties	Adaptation
Minn. Hybrid No. 402 Kingscrost Hybrid E Northwestern Red Dent Wis. No. 25 Yellow Dent	Zones 5, 6 & other northern corn growing locations.
Minn. Hybrid No. 401 Wis. Hybrid No. 350 Golden Glow Kingscrost E,	Zones 4 & 5.
Mich. Hybrid No. 1218 Pickett Yellow Dent M.A.C. Yellow Dent	Zone 3.
Iowa Hybrid No. 931 Ohio Hybrid K-23 DeKalb Hybrid No. 202 Wis. Hybrid No. 606 Wis. Hybrid No. 525 Duncan Yellow Dent	Zones 1 & 2.
Mich. Hybrid No. 561 Wis. Hybrid No. 645 Wis. Hybrid No. 570 Kingscrost Hybrid FB	Zone 1 & favorable locations in Zone 2.
Ohio Hybrid W17 Iowa Hybrid No. 939 Nebraska Hybrid No. 252 Illinois Hybrid No. 368 Illinois Hybrid No. 366 Indiana Hybrid No. 416	Sometimes matures at favorable locations or in favorable seasons in Southern Michigan.

The information presented on this page is designed to aid Michigan farmers in selecting adapted corn varieties and hybrids. The zoning of the map of Michigan is based on a study of records of the normal weather during the corn growing season in this state. The adaptation of corn varieties is influenced by soil, cultural practices and other factors besides weather so the zone divisions must be considered as general approximations rather than anything more specific. The varieties listed have been observed in several Michigan trials and the comparative moisture content of the grain at harvest time, and other kinds of information pertinent to relative time of maturity have been noted. For further information as to the relative merit of different varieties and hybrids, corn growers should study the more detailed information presented in this publication.

corn breeders of other states, and seedsmen. These trials have been located in southeastern Michigan (Monroe County), southwestern Michigan (St. Joseph County), central Michigan (Ingham and Saginaw counties), the Thumb District (Huron and Tuscola counties), and northern Michigan (Wexford and Otsego counties).

In each trial the corn strains tested are planted in three-row plots ten hills long. There are five such plots of each strain, the plot arrangement being altered for each series in order to reduce to a minimum the influence of soil variations on the comparative performance of the various strains. Observations are made of growth characteristics, relative time of maturity and other factors; the center row of each plot is harvested for total green weight to give an indication of the relative silage value of the different lines of corn; and finally, at the end of the growing season, the two outside rows are husked, the grain weighed, its moisture content determined, and comparative acre yields are calculated on the basis of bushels of shelled corn at 14 per cent moisture.

An annual report of these trials in mimeographed form is issued for all cooperators. However, the performances of a hybrid or any variety in a single test or in tests of a single season are entirely inadequate to establish the true value of that line. The soils in a single test plot vary—in some cases this variation is exceedingly large, seasons vary tremendously, and hybrids themselves are by no means 100 per cent uniform in their performance. Therefore, a series of tests over a period of years is required as a basis for establishing the merit of any particular line with reasonable assurance.

In this publication there is summarized, insofar as possible, the results of four years of over-state corn trials. Where two varieties have been compared in seven trials over the full four-year period, as in the case of Duncan and Michigan Hybrid No. 561, the reliability of the comparison is much greater than in the case of varieties compared in only three trials over a two-year period, as with Michigan Hybrid No. 561, and Wisconsin Hybrid No. 606. Presented in this publication are results of comparisons made in not fewer than three trials and covering not fewer than two seasons. Many hybrids, some of which are probably well adapted to certain Michigan conditions, have appeared in fewer than three of these trials and in no more than one season. The performance of such hybrids is not presented in this publication but will be presented at some future time when those hybrids have been tested further and a more adequate basis for evaluating their performance has been obtained.

Seed of Certain Hybrids of Proven Value is Certified by the Michigan Crop Improvement Association

In order that Michigan corn growers may have adequate sources of reliable seed of certain hybrids of proved merit, the Michigan Crop Improvement Association, under the supervision of the Farm Crops Department of the Michigan State College, conducts inspection and certification of such seed. Parent stock for hybrids, seed of which is certified for 1939 by the Michigan Crop Improvement Association was produced by the Farm Crops Department of Michigan State College. Certification, based on field and seed inspection, gives assurance as to adequate isolation of the hybrid seed-producing fields, thorough and

timely detasseling of the seed producing parent plants, drying, reasonable grading, and strong germination of the seed.

The seed of five good hybrids was inspected and certified by the Michigan Crop Improvement Association in 1938, and is available for 1939 plantings. A description of these hybrids and their adaptation follows:

Michigan Hybrid No. 561—Adapted for grain production to the stronger soils in the southern tier of Michigan counties, especially southeastern Michigan. Adapted for silage production as far north as Saginaw, Tuscola, and Huron counties, but too late for grain production in central Michigan, except under most favorable circumstances.

Michigan Hybrid No. 561 produces a large leafy plant with a heavy strong stalk which has stood up well even when infested by the European corn borer. The ear is carried fairly high on the stalk, cobs are medium in size, kernels bright yellow in color, tending to be smooth rather than deeply indented, vitreous rather than starchy and occasionally tending to be flinty. This hybrid stands up exceptionally well until maturity but may develop a moderate root weakness after the grain is ripe. It is superior to open-pollinated corn varieties of the same maturity in strength of stalk, leafiness, and yield. Its comparison with Duncan corn, a standard open-pollinated variety grown for many years in southern Michigan is given in Table 1.

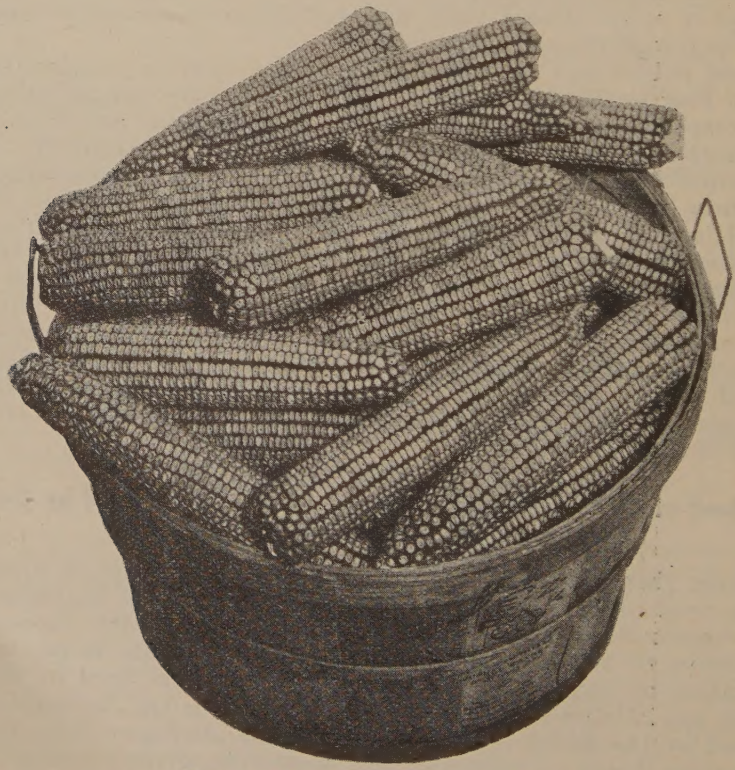


Fig. 1. Michigan Hybrid No. 561.

Table 1. Comparison of Michigan Hybrid No. 561 with Duncan Corn in Monroe and St. Joseph county trials, 1935-38.

Variety	Number of Trials	Number of Years	Average Silage Yield Tons per Acre	Average Moisture Content of Grain at Harvest	Average Grain Yield Bushels per Acre Basis—14% Moisture
Michigan Hybrid No. 561	7	4	9.6	33.3%	62.7
Duncan			6.2	31.4%	54.5

Wisconsin Hybrid No. 645—This is a stiff-stalked yellow dent hybrid developed by the Wisconsin Agricultural Experiment Station and the parent stock used to produce seed certified in Michigan comes from this source. No. 645 is a little later than Wisconsin Hybrid No. 606 and apparently somewhat more productive for conditions under which it will mature.

Wisconsin Hybrid No. 606—This hybrid was developed by corn breeders of the Wisconsin Agricultural Experiment Station and seed is certified in Michigan under a cooperative arrangement with the Wisconsin Station which supplies all parent stock. According to our estimates, Wisconsin Hybrid No. 606 is about four days earlier in maturity than Michigan Hybrid No. 561. For grain production, it is adapted to southern Michigan and is somewhat less critical as to location than Michigan No. 561. It does not produce quite as large silage yields as No. 561 but may be used for silage in the same general territory.

Wisconsin Hybrid No. 606 is a very uniform hybrid with very stiff stalks which stand up well even after the grain is fully mature. The grain is golden yellow in color, moderately indented and of good quality. In our trials, this variety has not differed materially from Duncan corn in yield but its superiority in stalk growth and other physical characteristics warrant its use by growers who have had good success with Duncan corn. These yield comparisons cover three trials in two years but the comparative results are supported by those secured in a number of demonstrational trials conducted by R. E. Decker, Extension Specialist in Farm Crops, Michigan State College, working in cooperation with vocational agricultural instructors and students. The comparison of Wisconsin Hybrid No. 606 and Duncan corn is given in Table 2.

Table 2. Comparison of Wisconsin Hybrid No. 606 with Duncan Corn in Monroe and St. Joseph county trials, 1937-38.

Variety	Number of Trials	Number of Years	Average Silage Yield Tons per Acre	Average Moisture Content of Grain at Harvest	Average Grain Yield Bushels per Acre Basis—14% Moisture
Wisconsin Hybrid No. 606	3	2	8.2	37.8%	52.5
Duncan			7.3	36.0%	52.7

Michigan Hybrid No. 1218—This hybrid is made by top-crossing Pickett corn with Michigan Inbred No. 1459. Being a top-cross, it is not so uniform as most double-crossed hybrids but it has been a very satisfactory variety in central Michigan trials. It has matured grain satisfactorily as far north as Huron County and should be acceptable in more southern locations in the state which require an earlier variety than Michigan No. 561 or Wisconsin No. 606. Michigan Hybrid No.

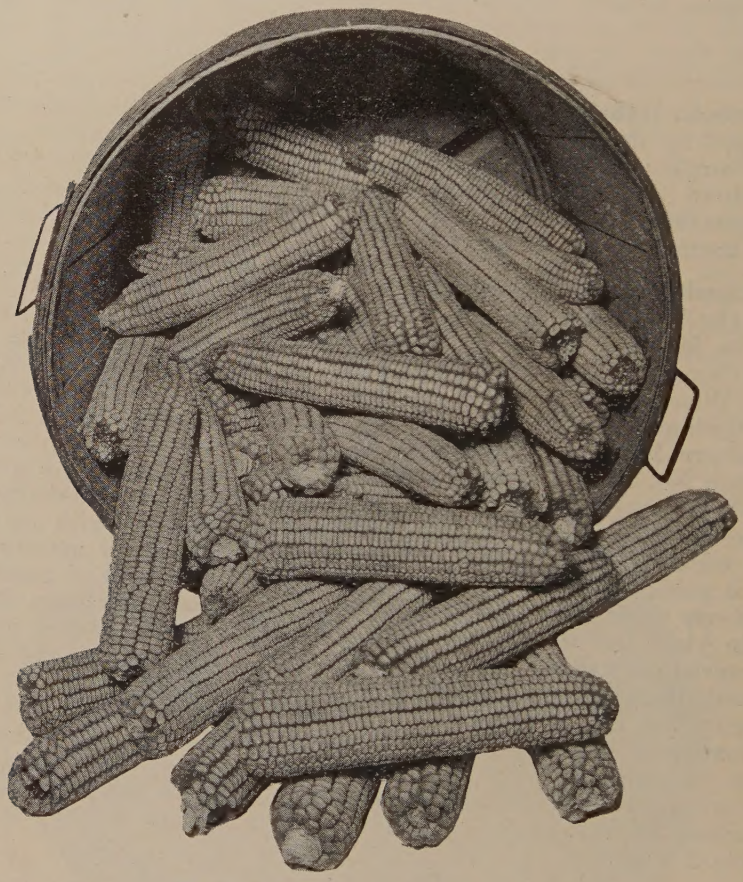


Fig. 2. Michigan Hybrid No. 1218.

1218 has a stronger stalk than Pickett and other open-pollinated corn varieties but is not as outstanding in this respect as Wisconsin No. 606 and some other double-crossed hybrids. The ear is medium in size in keeping with its earlier maturity, the kernels are bright yellow, medium in indentation and of good quality.

Since Michigan Hybrid No. 1218 is adapted to the same general territory as Pickett corn, a comparison with that standard open-pollinated variety is given in Table 3.

Minnesota Hybrid No. 402—This early hybrid developed by the Minnesota Agricultural Experiment Station involves both white and yellow inbred lines so the hybrid crop is mixed in color. It has, thus far, given the best yields of any hybrid or open-pollinated variety in the northern trials, is as early as any hybrid tested and generally matures its grain satisfactorily in both Wexford and Otsego counties where the trials have been conducted. Northern corn growers have found it very satisfactory and earlier than the early strains of Golden Glow frequently used in that section. In Table 4, it is compared with Northwestern

Fig. 3. Minnesota Hybrid No. 402.

Table 3. Comparison of Michigan Hybrid No. 1218 with Pickett Corn in trials conducted in Ingham, Saginaw, Tuscola and Huron counties, 1935-38.

Variety	Number of Trials	Number o Years	Average Silage Yield Tons per Acre	Average Moisture Content of Grain at Harvest	Average Grain Yield Bushels per Acre Basis—14% Moisture
Michigan Hybrid No. 1218....	8	4	10.1	32.2%	65.4
Pickett.....	.....	.....	8.5	33.7%	55.4

Red Dent, one of the earliest open-pollinated dent corns. The parent stocks for Minnesota No. 402 seed certified in Michigan are annually brought in from Minnesota.

Table 4. Comparison of Minnesota Hybrid No. 402 with Northwestern Dent in trials conducted in Wexford and Otsego counties, 1935-38.

Variety	Number of Trials	Number of Years	Average Silage Yield Tons per Acre	Average Moisture Content of Grain at Harvest	Average Grain Yield Bushels per Acre Basis—14% Moisture
Minnesota Hybrid No. 402....	8	4	6.9	43.1%	38.4
Northwestern Red Dent.....	.....	.....	6.5	42.4%	29.4

General Summary of Hybrid Corn Trials

The fact that Michigan Hybrids No. 561 and No. 1218, Wisconsin No. 606 and No. 645 and Minnesota No. 402 are the only hybrids which are now being certified by the Michigan Crop Improvement Association does not mean that these are the only hybrids adapted to certain sections of Michigan. However, corn growers who purchase out-of-state hybrid seed should take every precaution to make sure that the hybrid they buy is adapted to the location in which it is to be grown.

In Tables 5, 6, 7, and 8 are presented the comparison of several corn hybrids with a variety of known adaptation to a given locality. Because the actual yield in bushels to the acre is influenced so greatly by soil fertility and other environmental conditions, the comparisons in the following tables are expressed on a percentage basis.

Table 5. Grain yield of corn varieties which have been in three or more trials in southern Michigan, compared with that of Michigan No. 561 on a percentage basis.

Variety	Number of Trials in which Variety was Compared with Michigan Hybrid No. 561	Number of Years	Yield of Grain Expressed in Percentage of the Yield of Michigan Hybrid No. 561
GROUP No. 1—As early as, or somewhat earlier than, Michigan Hybrid No. 561.			
Michigan Hybrid No. 561	.....	.....	100%
Iowa Hybrid No. 931	4	4	98%
Kingscrost Hybrid F. B.	3	2	98%
Wisconsin Hybrid No. 606	3	2	90%
Duncan Yellow Dent	7	4	87%
GROUP No. 2—Later than Michigan Hybrid No. 561. Will require a very favorable season or other exceptional conditions to mature with safety in southern Michigan.			
Ohio Hybrid W-17	3	3	111%
Illinois Hybrid No. 368	3	3	110%
Iowa Hybrid No. 939	3	3	106%
Nebraska Hybrid No. 252	3	3	102%
Illinois Hybrid No. 366	5	4	90%

Table 6. Grain yields of corn varieties which have been in three or more trials in central Michigan, compared with that of Michigan Hybrid No. 1218, on a percentage basis.

Variety	Number of Trials in which Variety was Compared with Michigan Hybrid No. 1218	Number of Years	Yield of Grain Expressed in Percentage of the Yield of Michigan Hybrid No. 1218
GROUP No. 1—Of approximately the same adaptation as Michigan Hybrid No. 1218, or earlier.			
Michigan Hybrid No. 1218	.....	.....	100%
Minnesota Hybrid No. 402	3	3	95%
M. A. C. Yellow Dent	5	4	86%
Pickett Yellow Dent	5	4	85%
Golden Glow	4	4	76%
GROUP No. 2—Later in maturing than Michigan Hybrid No. 1218.			
Michigan Hybrid No. 561	4	3	100%
Wisconsin Hybrid No. 570	4	3	87%

Table 7. Grain yield of corn varieties, which have been in three or more official trials in the Michigan Thumb District, compared with Pickett Yellow Dent on a percentage basis.

Variety	Number of Trials in which Variety was Compared with Pickett	Number of Years	Yield of Grain Expressed in Percentage of the Yield of Pickett Yellow Dent
GROUP No. 1—Strains as early or earlier than Pickett.			
Michigan Hybrid No. 1218	3	3	115%
Pickett Yellow Dent	.....	.....	100%
Minnesota Hybrid No. 402	3	3	96%
Golden Glow Yellow Dent	4	4	86%
GROUP No. 2—Strains which, in these trials, appeared to be too late for this area.			
Wisconsin Hybrid No. 605	3	3	108%
Michigan Hybrid No. 561	3	3	96%
Duncan Yellow Dent	3	3	94%

Table 8. Grain yield of corn varieties, which have been in three or more official trials in northern Michigan, compared with that of Minnesota Hybrid No. 402 on a percentage basis.

Variety	Number of Trials in which Variety was Compared with Minnesota Hybrid No. 402	Number of Years	Yield of Grain Expressed in Percentage of the Yield of Minnesota Hybrid No. 402
GROUP No. 1—Of approximately the same adaptation as Minnesota Hybrid No. 402.			
Minnesota Hybrid No. 402	.....	.....	100%
Wisconsin Yellow Dent No. 25	6	3	95%
Kingscrost Hybrid E	6	3	94%
Northwestern Red Dent	8	4	77%
GROUP No. 2—Strains which, in these trials, appeared to be too late for this area.			
Michigan Hybrid No. 1218	3	2	94%
Minnesota Hybrid No. 401	5	4	94%
Kingscrost Hybrid E_2	4	2	88%
Wisconsin Hybrid No. 350	5	4	8?%
Golden Glow	6	3	79%
Wisconsin Hybrid No. 450	6	3	75%
Wisconsin Hybrid No. 404	4	3	75%
Wisconsin Hybrid No. 455	4	3	73%
Wisconsin Hybrid No. 525	4	4	72%
Wisconsin Hybrid No. 550	4	2	69%

SUGGESTIONS FOR THE CONTROL OF SAWFLIES ON CONIFERS

E. I. McDANIEL
Section of Entomology

Sawflies infesting conifers have become increasingly destructive during the last decade, and field observations in 1938 indicate the present infestation will not decline naturally. Sawflies are particularly destructive to conifers, at times killing large numbers of trees on young plantations, nursery stock and trees in ornamental plantings. With this abnormal level in the sawfly population, it is apparent that a better understanding of the habits and life-history of the more important species should aid the grower in timing control measures to obtain the most satisfactory results.

Young sawfly larvae are gregarious. They usually feed in groups of a dozen or more. In many species this habit of feeding in colonies continues through the larval stage. At first the young larvae devour only the tender part of the foliage; later they consume the entire needle and may feed on the tender bark, girdling twigs and branches. From three to five weeks are required to complete their development. Certain species produce two broods each season, while others are limited to one. The spring brood usually restricts its feeding activities to the mature foliage while those of the second brood often consume the foliage of the current season's growth. The larvae are naked caterpillars with six true legs on the thorax and six or eight fleshy unsegmented prolegs on the abdomen. The caterpillars of sawflies are readily separated from the caterpillars of moths, since the fleshy prolegs of the sawfly larvae are not ornamented with the spine-like disk common to the larvae of moths.

Sawflies are so called because of the complicated egg-laying device of the female. This consists of several sharp-toothed, saw-like blades used by the insects to insert the eggs into the plant tissue. The adults are, for the most part, inconspicuous, thick-waisted wasp-like insects. They are seldom observed since they deposit their eggs and disappear long before the eggs hatch. Not all adults of a brood emerge the same season. In some cases a certain percentage of individuals will hold over until the following season before they emerge and deposit their eggs. This is an important item to consider when planning control measures—any effort to be productive should be followed for at least two consecutive years.

The following species of sawflies have been especially destructive in Michigan plantings during the season of 1938: The larch sawfly, *Lygaeonematus erichsonii*; Abbott's sawfly, *Neodiprion pinetum;* the red-headed sawfly, *Neodiprion lecontei*, and the imported sawfly, *Diprion simile.*

The larch sawfly, *Lygaeonematus erichsonii*, is practically restricted to larch. It is generally considered to be the most destructive of the

conifer sawflies, with its distribution limited only by that of its host plant. It is usually considered as a forest insect with a decided preference for mature trees, but young trees, nursery stock and trees on ornamental plantings are also attacked. The infestation usually develops first in the top of the trees. Not only do the trees suffer from defoliation by the larvae early in the season but the tender new growth is deformed and twisted by injuries resulting from the egg-laying punctures of the female.

There is one annual generation; the female appears after the new growth is several inches long and inserts her eggs into the tender green stems. Usually the eggs are inserted into the twig only on one side, which causes the twig to twist and curl. The larvae as they appear settle upon the previous season's growth. When present in sufficient numbers, they are capable of defoliating a tree. When mature, the larvae measure about two-thirds of an inch in length. The head and feet are black while the body is an all-over green of about the same tone as the under sides of the larch leaves. When disturbed, the larvae have the habit of assuming a "U" position, head and tail held rigid. This species is gregarious throughout its larval stages. The larvae complete their development late in June and after dropping to the ground, spin tough, papery cocoons in the soil and in duff under the trees, where they remain as larvae until the following spring, when they go into a resting stage. Then many individuals transform into wasp-like adult insects which emerge and place eggs for the current generation; others remain in the ground until the following spring before transforming into adults. Defoliated trees may put out new foliage and survive an outbreak provided other insect enemies, such as bark beetles and wood borers, do not kill the trees before they can regain their vitality. It is possible to control the larch sawfly with a properly timed application of a stomach poison or a contact spray. Usually the difficulty of getting the insecticide to the trees presents a problem.

Abbott's sawfly, *Neodiprion pinetum,* is the predominating species of sawfly attacking white pine in the southern third of the state. The larva is readily separated from *N. lecontei* by the fact that the head is always black. The larva is gray-green ornamented with regular rows of rectangular black spots. There are two broods of larvae each season, one in June-July, the second in August-September. Where an infestation is of old standing the broods overlap, and larvae in all stages of development may occur in a planting from June into October. Many larvae of the summer brood spin up in the foliage of the host tree, while those of the fall brood all drop to the ground and pupate under the soil. The eggs are inserted into the foliage.

The red-headed pine sawfly, *Neodiprion lecontei,* is common in the northern two-thirds of the state. It infests a wider range of host plants than *N. pinetum* and is correspondingly more destructive. It has been taken on Austrian pine, Scotch pine, red pine, jack pine and Mugho pine. During 1938 it was particularly destructive in red pine and jack pine plantings. The mature larva is whitish-yellow ornamented with rows of black dots. The head is red. There are two generations each year. The peak of the spring brood occurs in June-July, while the summer brood is most in evidence in September-October. Where the infestation is of long stand-

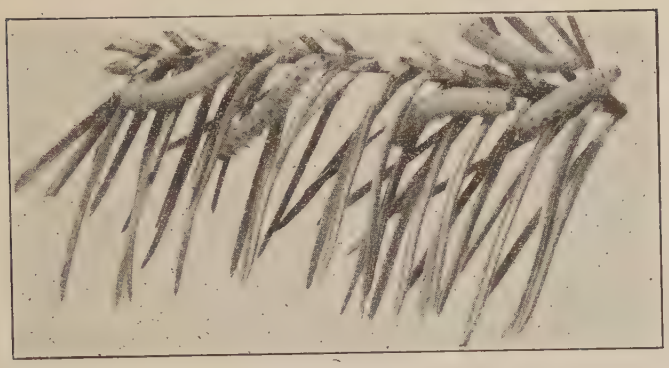


Fig. 1. Larvae of the red-headed pine sawfly.

ing, or of any great intensity, the broods overlap to such an extent that it is difficult to differentiate between them.

The imported pine sawfly, *Diprion similis,* is a European species which made its appearance in the United States some time previous to 1915. It has been recorded here and there throughout the northeastern United States, and in 1937 an infestation was discovered in a large planting of mixed conifers in the vicinity of Monroe, Mich. So far it has restricted its feeding to Scotch pine. There are two broods a year. The larvae of the summer brood mostly spin up on the foliage whole those of the summer brood enter the ground to form their cocoons. The adult sawfly lays her eggs in the needles.

Control

Since each infestation is an individual problem, several types of control are suggested. Without question, where a large acreage is involved, an arsenical spray is the most satisfactory. A spray with the following proportions has been found satisfactory:

3 pounds lead arsenate
1 quart summer oil
100 gallons of water

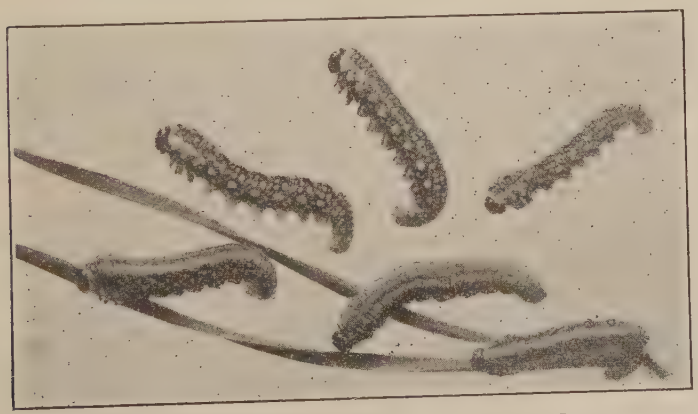


Fig. 2. Larvae of the imported pine sawfly.

For best results this spray should be applied with a power rig giving at least 200 to 300 pounds pressure.

On small plantings, or where the infestation is restricted to a few individual trees a dust applied with a hand duster is recommended. There are several small crank type dusters, costing around ten dollars, which have proved satisfactory. Of the dusts tested, three were found satisfactory; cryolite, calcium, arsenate and rotenone dust. Of these, both cryolite and calcium arsenate gave 100 per cent control.

*Cryolite was applied both undiluted and diluted with 3 parts talc as a carrier; no burning resulted and all larvae were killed, even those practically mature.

Calcium arsenate was diluted one part to ten parts hydrated lime. The control was equally good to that obtained with cryolite.

A rotenone dust containing .075 per cent rotenone killed a number of the larvae. It acted slowly, approximately 72 hours being necessary to obtain any indication of the kill. In all probability, this dust will be useful where an infestation occurs in the vicinity of vegetables or in outside living rooms.

It is possible to knock sawfly larvae from the trees and then to band trees with cotton, or sticky barriers, to prevent the larvae from re-establishing themselves upon the trees; in any event, take precautions to prevent their re-establishing themselves on their host-tree.

A NEW FUSARIUM-WILT-RESISTANT TOMATO

M. C. STRONG
Section of Botany

A Fusarium-wilt-resistant strain of John Baer has been developed at the Michigan State College to fill the need of growers for a wilt-resistant, second early, market garden and canning tomato adapted to a short growing season. It is well known that tomatoes which are naturally self-fertilized, may be improved by isolating hereditary characters by selection. Whether John Baer may be regarded as a heterogeneous variety and the characters selected in this case were normally present in the variety, or whether they were the result of accidental crosses or mutations need not be discussed here.

Method of Development

The procedure followed was one of selection in soil artificially infested with 50 different isolates of *Fusarium lycopersici* which were obtained from various localities in Michigan as well as from Maryland, New Jersey, South Carolina, Tennessee, Wisconsin, Illinois, Indiana, Florida, Louisiana, Kansas, Missouri, Colorado, Arizona, California, Australia, and South Africa. Pure cultures of these isolates were grown

*The cryolite used contained sodium fluoaluminate 85 per cent and fluorine 45 per cent.

on sterilized oats in large containers at a temperature of 28° C. After about four weeks, when the fungus had grown over all the oats, the cultures were broken up and placed in large tubs where they were well mixed together. This composite mixture of cultures was the inoculum added to the seed bed soil and to compost used in transplanting seedlings to pots or flats. When the six-weeks old transplants were set in the field, a handful of the inoculum was placed beneath each plant in close proximity to the roots. Consequently many susceptible plants were eliminated in the seedling stage. Those that survived the field trial, since they had been subjected to three inoculations at different growth stages, were fairly certain to possess some degree of resistance, not merely to have escaped infection. The field trials were conducted on the same plot of ground year after year, and more inoculum was added to the soil each season.

Plants were examined for evidence of disease at several stages of growth. At the time of setting in the field, those already showing wilting, yellowing of leaves, and browning of vascular bundles were discarded. When fruit was beginning to ripen, the plants were again examined for visible symptoms of wilt. At the end of the season, all plants were cut across the base of the stem and examined for browning of the vascular bundles. Tissue plantings on culture media were made to determine the presence or absence of *Fusarium lycopersici*. The wilt fungus is often present in the vascular tissues of plants that show no external symptoms of disease. Seasonal infection records given here are based on the presence of this fungus in the vascular tissues, not merely on the criterion of external symptoms of wilt.

In making selections several points were kept in mind—plant type, fruit type, productiveness, and absence of the wilt fungus from the vascular tissues.

Origin and History

In the 1934 variety tests for resistance to Fusarium wilt, commercial John Baer (seed from Grand Rapids Growers Association) showed 65 per cent infection. From the surviving John Baer plants, the best individual was selected and seed was saved.

In 1935, the progeny of this plant was grown in wilt-infested soil as described above. This selection showed only 11 per cent wilt infection during the entire season as compared with commercial John Baer in which 74 per cent wilt developed. Five excellent plants showing no evidence of this disease were selected and seed was saved separately. Three of these selections were eliminated in green house trials during the winter, and in the spring of 1936 the other two (numbers 33 and 34) were planted in the wilt-infested field.

In 1936, the progeny of No. 33 (495 plants) were uniform large plants with a heavy set of rather flat-shaped fruit. The wilt infection was 27 per cent as compared to 62 per cent in commercial John Baer. The progeny of No. 34 (495 plants) showed only 7 per cent wilt infection and were uniformly tall, erect plants with large, oblate fruits. Number 34 was a more desirable tomato both from the standpoint of wilt resistance and fruit type. Three individual plants, (a), (b), and (c), were selected from this strain and seed was saved separately.

Green house trials eliminated selection No. 34a but the progenies of No. 34b and No. 34c were tested in the wilt-infested field in 1937,

and showed respectively 19 per cent and 23 per cent wilt infection as compared with 82 per cent in commercial John Baer. Both selections produced large, smooth, oblate fruits but No. 34c was seven to ten days later in maturing fruit than No. 34b and was discarded for this reason. Five individual plants were selected from No. 34b. Examination showed them to be free from the wilt fungus.

Progenies of these five selections were grown in 1938 in wilt-infested soil, as previously described. The plants were alike in appearance, in productiveness, and in yielding smooth, red, oblate fruits of uniform size. All five selections showed similar wilt resistance, ranging from 15 per cent to 19 per cent infection as compared with 62 per cent in commercial John Baer. It has been shown that selection in tomatoes will improve a variety by isolating hereditary characters, but once the strain has become uniform, futher selection will not intensify these characters. Since selection No. 34b produced uniform plants and fruits for two generations, it was concluded that further selection would be useless and therefore, the seed from the 1938 trials was combined.

The wilt infection percentages given above represent infection appearing after the plants were set in the field and do not include the number of plants already diseased which were discarded at that time. The percentage of wilt infection in the commercial John Baer variety would be greater if these discarded plants were included with the field record. However, this early infection is even more significant when considered from another standpoint.

The number of plants showing infection during the season is not the only consideration in determining the wilt resistance of tomato

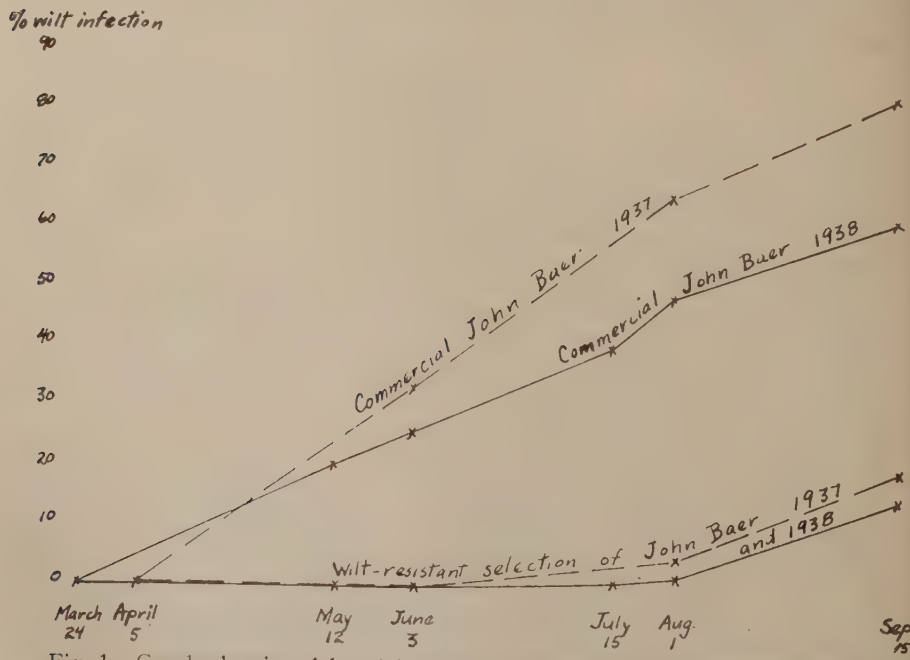


Fig. 1. Graph showing delayed infection in Fusarium wilt-resistant selection of John Baer as compared with the commercial variety.

Fig. 2. Comparison between stands of Fusarium wilt-resistant selection and of commercial John Baer early in August. The two rows diagonally across the center of the picture are the commercial variety.

varieties. The time when infection occurs is also of importance. Plants becoming infected as late in the season as July or August will bear a crop of fruit before they succumb to the disease, while plants that are infected in May and June will have slight chance of producing mature fruit.

The graph in Fig. 1 illustrates the delayed infection of the wilt-resistant selection as compared with the commercial variety. On May 12, 1938, before time for setting in the field, 20 per cent of the commercial John Baer plants already showed severe wilt symptoms, while the wilt-resistant plants appeared perfectly healthy. The wilt-resistant selection showed no symptoms of the disease before the middle of July when fruit was beginning to ripen. At this time only 1 per cent infection was apparent in these plants as compared to 40 per cent in the commercial variety. The comparisons for 1937 present a similar picture. On June third, when the plants were set in the field, the wilt-resistant selection appeared healthy while the commercial John Baer plants showed 33 per cent wilt. By August first, 65 per cent infection was evident in the commercial variety as compared with 5 per cent in the wilt-resistant selection.

Characterization

The Fusarium-wilt-resistant selection of John Baer is in other respects, similar to the commercial variety, and may be characterized briefly as second early, requiring 63 to 73 days from transplanting medium-sized plants not yet in blossom to the first commercial harvest.

Plant medium-sized, semi-erect and spreading, foliage medium-dense, fruits moderately shaded. Ripe fruits deep oblate, 5½ to 6½ ounces. Cavity shallow, smooth, stylar end well rounded, scar small. Color grenadine to scarlet red. Walls medium, cells 6 to 7, regular. Radial cracks common, circular cracks rare.

Fig. 3. A first cluster of Fusarium wilt-resistant John Baer on the vine.

Adaptation

This strain should be adapted to all regions where John Baer is grown, and particularly where Fusarium wilt is prevalent. The resistance to Fusarium wilt is high, comparing favorably with such well known varieties as Marglobe and Pritchard. It is about one week earlier than Marglobe, and the quality of fruit is superior to Pritchard. Resistance and susceptibility to wilt infection are known to be considerably influenced by seasonal conditions of temperature and moisture. This tomato has been tested over a period of four years and has varied between 7 per cent and 19 per cent wilt infection. The trials

have been carried on in soils heavily infested with many different isolates of the causal fungus. While these isolates may not comprise all the possible existing strains of *Fusarium lycopersici*, their divergent geographical origin should insure a wide range of adaptability for this tomato.

On a fertile sandy loam soil, heavily wilt-infested, this wilt-resistant selection of John Baer yielded an average of 12.5 lbs. of fruit per plant, or approximately 20 tons per acre. Under the same conditions, commercial John Baer yielded 5 pounds of fruit per plant, or approximately 8 tons per acre.

Source of Seed

The Michigan Agricultural Experiment Station has no seed of this variety for sale. A number of commercial companies are being supplied with a limited quantity of seed for trial and for the purpose of increase. Distribution of the seed in this manner will enable commercial seedmen to supply demands for this variety.

VITAMIN A ACTIVITY OF MILK FAT*

L. A. MOORE
Section of Dairy Husbandry

Among the many vitamins essential for optimal nutrition, vitamin A was one of the first to be discovered. Two groups of substances possess vitamin A activity in nature. One group, the true or colorless vitamin A such as found in liver oils, we might term the animal form. There are at least two members of this group, called A_1 and A_2. Thus far only the A_1 factor has been isolated in pure form. The other group known as the carotenes are reddish yellow pigments which are responsible for the yellow color of carrots and which we might term the plant form of vitamin A. There are four slightly different but closely related members which fall in this group. When an animal consumes these carotenes they are carried by the blood stream to the liver where they are changed to true vitamin A.

Milk fat contains both forms of vitamin A and in this discussion the combined biological effect of the two will be termed vitamin A activity.

When an animal receives insufficient vitamin A various symptoms appear. One of the first to occur is night blindness, a condition in which the animal can see properly in bright light but cannot see in dim light such as at dusk. Mild degrees of this condition probably exist in human beings more often than has been suspected in the past. In case of more serious deficiency loss of weight which is frequently accompanied by infections involving the eyes, salivary glands and lungs may occur. A deficiency of vitamin A is also associated with diarrhea, development of kidney stones, and degeneration of nerve tissue.

*From a portion of a thesis presented to the graduate school of Michigan State College as partial requirement for the Ph. D. degree.

The requirement of human beings for vitamin A has not been studied in sufficient detail to give exact figures. Estimates (1) of 1,400 to 2,000 units daily have been made for an adult as just enough to prevent the development of night blindness. This would be a minimal requirement while an estimate of 3,000 units has been made as ample for some storage of the factor in the liver. Estimates of 6,000 to 8,000 units have been made for growing children as sufficient to supply extra needs associated with growth, development and moderate body storage.

The chief sources of vitamin A for human beings are green leafy vegetables, peas, carrots, sweet potatoes, eggs, fish liver oils, milk, butter and cheese.

Many studies have been conducted at various experiment stations in this country and Europe on the vitamin A activity of milk fat as produced by the cow. The results show that the carotene content of the feed consumed is the most important factor. Thus milk produced on winter feed is much lower in its vitamin A activity than milk produced on green summer pasture. Dry pastures during the summer will cause some reduction compared to spring pasture because of lower carotene content. The feeding of roughages rich in carotene during the winter months will tend to promote the maintenance of the vitamin A activity of the milk fat at a summer level.

A significant observation (2) has been made in connection with the variation of the true vitamin A and carotene content of the milk fat of the different breeds. It has been found that with the same feeding conditions, the milk fat of the Holstein and Ayrshire has more of its vitamin A activity present as true vitamin A and less as carotene. In the case of the Guernsey or Jersey breeds the opposite is true. However, the total vitamin A activity of the different breeds per unit weight of fat is approximately the same.

In 1934 it was decided to study the vitamin A activity of milk fat as produced under Michigan conditions.

Experimental

Monthly milk fat samples were saved from a large supply of milk which came to the Michigan State College creamery from surrounding farms. The samples were therefore a composite of milk fat produced under the varying conditions existing on these farms. Monthly samples were also obtained from a Holstein cow (No. 174) of the Michigan State College dairy herd. This cow had calved in December 1934 and the first sample was taken a few days after calving, as soon as the milk was fit for use. This animal had been on pasture the previous summer and was receiving an ordinary winter ration of alfalfa hay, corn silage and grain. Milk fat samples were also obtained from a Holstein cow (No. A 14) in the Michigan State College experimental herd. She had always received alfalfa hay and a grain ration and had never been on pasture. Likewise with this cow, the first sample was obtained a few days after calving.

The vitamin A activity of these samples was determined by a biological method (3) using white rats.

In addition samples of milk fat were obtained from two groups of cows on winter feed before and after feeding silages put up by the

A. I. V.* methods.** One silage consisted of alfalfa and the other was a combination of oats and peas. Silage put up by this method is handled in the usual manner except that during the filling process, mineral acids are added as a means of preservation. This type of silage usually contains much more carotene than ordinary winter roughages. The vitamin A activity of these samples of milk fat was determined by a chemical method (4) and an attempt was made to place the results on the same basis as those obtained by the biological method of assay.

Results

The results obtained on the vitamin A activity of the milk fat samples shown in Tables 1, 2, and 3 have been expressed in terms of international units per quart of milk. The international unit is a biological unit adopted by the League of Nations committee on standards.

It will be noted in Table 1 showing the results with the samples obtained from the College creamery that when the herds were turned to pasture in May the vitamin A activity tripled and held up well until October when there was some decline.

Table 1. Effect of season on vitamin A activity of milk fat.

Date	International Units per Quart of 3.5% Milk		
	M. S. C. Creamery	Cow 174	Cow A-14
Dec. 1934	1,573	2,120	1,607
Jan. 1935	992	821	1,060
Feb. 1935	821	889	958
Mar. 1935	889	1,026	479*
Apr. 1935	718	1,334	513
May 1935	.....	983**	.....
May 1935	2,189	1,778***	513
June 1935	1,539	2,394	923
July 1935	1,607	2,667	1,778****
Aug. 1935	2,565	1,539	1,094
Sept. 1935	1,949	2,565	1,915
Oct. 1935	1,471	1,710	.....
Nov. 1935	1,300	1,197	.....

*Hay fed dropped from 30 to 20 lbs. per day.
**May 8 before pasture.
***May 28 after two weeks pasture.
****Fed 1935 hay for two weeks.

The results with cow 174 from the College dairy herd showed much the same trend. The effect of pasture is well demonstrated by the two May samples. The second May sample was taken after the cow had been on pasture for two weeks and shows the quick response to pasture. It will also be noted that the first sample from this animal was high in vitamin A activity. This was the sample taken a few days after calving.

The results obtained with cow A 14 are similar to those of cow 174. It will be noted that owing to lowered hay consumption in March the vitamin A activity of the milk fat dropped considerably. It continued to

*"A. I. V." is designation of the acid treatment, named after the originator.
**Samples obtained from the Ira Wilson & Sons Dairy Farm at Fowlerville.

Table 2. Effect of feeding A. I. V. alfalfa silage on vitamin A activity of milk fat.

Days After Adding Silage	International Units per Quart of 3.5% Milk
0	616
7	804
15	1,129
20	1,180
27	1,464

be low until July when new 1935 hay was fed, which resulted in a considerable increase in the vitamin A activity of the milk fat.

The results in Table 2 show that the feeding of A. I. V. alfalfa silage produced a considerable increase in the vitamin A activity of the milk fed although not equal to that produced on summer pasture. Table 3 likewise shows that the feeding of A. I. V. oat and pea silage increased the vitamin A activity of the milk fat.

Table 3. Effect of feeding A. I. V. oat and pea silage on vitamin A activity of milk fat.

Days After Adding Silage	International Units per Quart of 3.5% Milk
0	513
7	1,129
14	1,505

Discussion of Results

The results show clearly that under Michigan conditions pasture produces a considerable increase in the vitamin A activity of milk fat. The reason for this is the high carotene content of green pasture grasses. Green pasture may contain from 200 to 300 parts per million of carotene on the dry basis, while alfalfa hay fed during the winter may contain only 15 to 50 parts per million. Alfalfa loses much of its carotene during the curing process and the loss continues during storage. This loss is greatest during the warm summer, fall, and spring months and least in the winter months.

When A. I. V. alfalfa or oat and pea silages were fed they also produced a considerable increase in the vitamin A activity of the milk fat. These results naturally raise the question of the preservation of roughages for winter feeding in order to produce milk of high nutritional value during this period. The A. I. V. method, while apparently efficient in the preservaton of carotene, is not used by the average dairy farmer to any great extent because of the need of chemical supervision during the filling process and special equipment for the application of the acids.

Studies are now in progress at several stations on the preservation of alfalfa or grasses with and without molasses. The results have been conflicting but after such factors as fineness of cutting, proper mois-

ture content, packing, stage of cutting and possibly others have been thoroughly investigated it may be possible to produce a silage rich in carotene by a more practical method.

The addition of phosphoric acid to green roughages for silage may offer a means of solution. However, to date figures on carotene preservation with this acid are not available.

The feeding of artificially dried hay offers another means of keeping up the vitamin A activity of milk fat during the winter months but involves a considerable investment for equipment and is expensive to operate.

The feeding of carrots has been advocated but is not very practical because of the labor involved in raising and handling the crop. It is also necessary to feed more than 10 pounds per day in order to obtain a worth while increase in the vitamin A activity of milk. It seems that a considerable amount of carotene must be added to a winter ration in order to obtain any measurable change in the milk fat. This is probably because the cow utilizes carotene inefficiently since estimates have shown that only 1 to 3 per cent is transferred to the milk as vitamin A activity.

The results show that under ordinary farm conditions summer milk has a much higher nutritional value than winter milk. It is to be regretted that butter produced while cows are on spring pasture is discriminated against on certain markets when it is actually more valuable from a nutritional point of view.

The vitamin A activity of milk fat is sufficient to be of considerable importance as a source of this factor in the human dietary. One quart per day is sufficient on the average to take care of the minimum vitamin A requirements for an adult according to the values previously given. The use of butter, cheese and ice cream would further increase this intake.

These results are in agreement with previously published data on the vitamin A activity of milk fat.

Summary

1. The vitamin A activity of milk fat varies with the season, being highest during the summer months and becoming increasingly low during the winter months.
2. This variation is due to a difference in carotene intake.
3. The feeding of feeds rich in carotene during the winter tends to increase the vitamin A activity of milk fat toward the summer level.
4. One quart of milk per day has sufficient vitamin A activity on the average to meet the estimated minimal vitamin A requirement of the adult.

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THE PONTIAC POTATO

H. C. MOORE AND E. J. WHEELER
SECTION OF FARM CROPS

The Pontiac is one of the seedlings resulting from a Katahdin—Bliss Triumph cross made in 1930 by potato breeders of the United States Department of Agriculture. The seed from this cross was planted at the Potato Experiment Farm, Lake City, Mich. In 1931 the Pontiac was selected from several hundred of the resultant seedlings by members of the Farm Crops Department. This variety has been named Pontiac for the famous chief of the Ottawa Indian tribe which inhabited the Great Lakes region in Colonial times.

Since 1931 it has been grown in several localities in the lower peninsula as seedling number 401-23. In most instances the results have been satisfactory and the growers have been well pleased with its high yield, good quality and vigorous growth. For the last three years it has been grown in trial plots in Florida, Louisiana, Iowa, and North Dakota with encouraging results. The interest shown in this seedling by both Michigan and out-of-state growers warrants its introduction to Michigan farmers under a variety name, so that it can be more generally tested and its true worth be more quickly determined.

The Pontiac is a late maturing red potato, round to oblong in shape with medium deep eyes and crisp white flesh. The plant has large, dark green, rough-textured leaves and makes a vigorous upright growth. Comparing the Pontiac with its parents, the Katahdin and Bliss Triumph, the tubers closely resemble those of the Triumph in general shape and color, though in potatoes exceeding 8 ounces in weight the shape is more oblong than round. The Pontiac plant is much like the Triumph except that its growth is more vigorous. The leaves are flat and do not roll like those of the Katahdin. It sets four or more tubers per hill and resembles the Katahdin in its high percentage of number one potatoes. Its tubers are set close to the stem and deep. This deep setting habit appeals to growers who have had difficulty with the shallow setting of the Katahdin.

The Pontiac has not shown any marked resistance to insect and disease attacks; neither has it been much more susceptible than are standard varieties, such as Russet Rural, Green Mountain, Chippewa. Mosaic has been the major virus disease observed in Pontiac plots. Yellow dwarf has not developed in this variety to the extent that it has in Katahdin, Russet Rural, and Irish Cobbler. In some trials in Michigan and Iowa the Pontiac has proved more drouth-resistant than

*Table 1. Yields of potato varieties grown on college muck plots, East Lansing.

Variety	Yield Per Acre Bushels							
	1936		1937		1938		Average	
	U. S. No. 1	Total yield	U. S. No. 1	Total yield	U. S. No. 1	Total yield	U. S. No. 1	Total yield
Pontiac	292.9	305.6	459.0	513.9	727.2	763.3	493.03	527.93
Russet Rural	193.7	238.2	164.3	294.0	501.0	543.0	286.33	358.40
Chippewa	194.7	220.0	337.2	406.4	784.0	875.3	438.63	500.56
Katahdin	348.1	357.3	380.4	415.0	583.4	632.6	437.30	468.30
Irish Cobbler	186.5	248.7	410.6	510.0	614.5	757.0	403.86	505.23

*Data furnished by Paul M. Harmer, Soils Department, M. S. C.

other varieties and has been freer from hollow heart and misshapen tubers.

In variety yield tests on the college muck plots at East Lansing the Pontiac has out-yielded other varieties except in 1936 when it was exceeded by Katahdin and in 1938 by Chippewa. The results of three years' tests are given in Table 1.

Several growers who have tried the Pontiac on muck soil report that it produces high yields with a high percentage of U. S. No. 1 potatoes, and that the tubers set deep and are free from sunburn injury.

The Pontiac also compares favorably with other varieties on upland soil. On sandy loam soils at East Lansing and Lake City in 1937 and 1938 it averaged slightly better than Russet Rural and Katahdin and practically the same as Chippewa in yields of U. S. No. 1 potatoes. It out-yielded Irish Cobbler 74 bushels per acre. Detailed results of this test are given in Table 2.

In 1938 approximately five acres of Pontiac potatoes were grown under the inspection service of the Michigan Crop Improvement Association, and a few hundred bushels of certified seed are available in small quantities to Michigan growers. Information concerning sources of seed may be obtained from the Farm Crops Department, Michigan State College, East Lansing.

Table 2. Yields of potato varieties grown on sandy loam soil at East Lansing and Lake City.

Variety	Yield Per Acre Bushels								Average	
	1937				1938					
	East Lansing		Lake City		East Lansing		Lake City			
	U. S. No. 1	Total	U. S. No. 1	Total	U. S. No. 1	Total	U. S. No. 1	Total	U. S. No. 1	Total
Pontiac	192	199	98	131	303	348	230	261	206	235
Russet Rural	144	193	93	140	291	320	241	287	192	236
Chippewa	203	223	111	128	267	320	248	275	207	236
Katahdin	149	160	97	135	260	270	274	294	195	215
Irish Cobbler	144	171	78	110	162	184	145	173	132	159

EARLY CUTTING AND FERTILIZATION OF QUACK GRASS MEADOWS

S. T. DEXTER AND D. L. CLANAHAN
SECTION OF FARM CROPS

In many parts of the Upper Peninsula of Michigan, most of the cleared land is occupied by grass meadows. Much of this grassland has lain undisturbed by the plow for several years. When seedings are made in this region, the stand of clover and other legumes is usually rather poor, and the resulting sod is usually predominantly grass. For a year or two, timothy may be a prominent part of the stand, but this very shortly gives way to a mixture of quack grass and bluegrass. These fields give a fair yield of grass hay, which may be harvested year after year with little outlay of labor or cash. The production of grain in this region is difficult and insufficient for the rations of the dairy cows that are kept there. Consequently, about $1,000,000 is spent annually for high-protein feeds in an attempt to balance the low-protein hay that is available locally.

In this region the amount of cleared land per farm is small, about 30 acres per farm. The power for preparation for seedbeds is inadequate, less than 1 horse per farm. Many of the farmers are or recently have been employed part-time in other industries and their experience has been only incidentally agricultural. Much of the land needs lime before legumes will make good growth. The surrounding lakes, cool nights, dewy mornings, and frequent rains make hay curing difficult. The hay is usually left standing until it is very ripe. In some regions, the maintenance of an acid soil has seemed necessary to avoid scab in the white-skinned potatoes produced.

This combination of circumstances has led to the perpetuation of agricultural conditions described. Despite past and present efforts of the agricultural experiment station and the extension service, the acreage of red clover, alfalfa and alsike clover remains small in this region. In isolated cases, excellent fields of alfalfa may be seen. These appear to have been established by the ordinary methods. Hard work, adequate power to prepare a clean, firm seedbed, a "sweet" soil, and perhaps fertilizer have been combined to give these productive hay fields. Such fields, however, are decidedly exceptional in most of this territory. Until a larger quantity of home-grown legume forage is available some provision must be made to provide extra protein for livestock rations.

With those facts in mind, a demonstration was arranged with the extension staff of the Upper Peninsula, providing for early and late cutting of quack grass meadows on plats with and without a high-nitrogen fertilizer. Previous work had shown that such early-cut hay was decidedly higher in crude protein than late-cut hay, particularly when fertilized. In each county of the Upper Peninsula, a suitable

quack grass meadow was selected, in which an area one and one-half acres in size was laid out. Two half-acre check plats were provided, one on each side of the fertilized area. In general, the fertilization consisted of ammonium sulphate broadcast at the rate of 200 pounds per acre, during the first week of May. Ammonium sulphate was used as a source of nitrogen because it is readily obtained in that region and cannot be confused with other fertilizers. Other forms of nitrogenous fertilizer have been used with comparable results. Since 10 or 12 such plats were laid out, fertilization and cutting dates varied slightly at different locations. In general, however, fertilization and cuttings were made in the southern counties first, so that the season was about comparable at the various plats.

The first cutting was taken from June 17 to June 25 in 1936 and in the corresponding week in 1937 and 1938. The later cutting was made the second week in July each year. In general, this later date was about the beginning of haying season in the Upper Peninsula. Across the two unfertilized areas and the fertilized plat three swaths were cut with the farmer's mower, to sample the area thoroughly. Measured lengths of these swaths were raked at once and weighed green. Samples were taken from the green hay of both the fertilized and the unfertilized areas, immediately after weighing. These samples were dried in an oven, with circulating hot air, at about 65° C. and weighed. The percentage of dry matter in the green hay was determined and the yield per acre thus computed. The dried samples were turned over to the Section of Agricultural Chemistry for analysis.

The accompanying table shows the average yield of hay, on a 15 per cent moisture basis, the percentage protein in this hay and the yield of protein per acre over the three-year period.

Table 1.

	Early Cutting				Late Cutting			
		Hay (lb.)	Per cent protein	Pounds protein per acre		Hay (lb.)	Per cent protein	Pounds protein per acre
1936	Ck.	1,428	10.43	149	1936 Ck.	1,927	7.11	137
	Fert.	2,688	11.05	297	Fert.	2,965	7.39	219
1937	Ck.	1,359	8.80	123	1937 Ck.	1,741	5.15	89.7
	Fert.	2,707	9.72	246	Fert.	2,855	5.75	164.2
1938	Ck.	2,193	8.89	165	1938 Ck.	3,070	6.81	177
	Fert.	3,612	10.38	318	Fert.	4,149	7.20	258
Av.	Ck.	1,660	8.80	146	Av. Ck.	2,249	6.00	135
	Fert.	3,144	9.13	287	Fert.	3,310	6.47	214

By examination of the table, certain comparisons may be brought out. Early cutting with fertilizer may be compared with the current practice, namely, late cutting without fertilizer. On this basis, it may be noted that in 1936, the yield of protein was increased from 137 to 297 pounds per acre; in 1937, from 89.7 to 246; in 1938, from 177 to

318 pounds protein per acre. Nineteen thirty-six was a dry year, 1937, a very dry year, and 1938 a rather wet year. The yield of hay per acre, comparing early-fertilized with late-unfertilized, was in 1936—1,927 pounds to 2,688; in 1937, 1,741 pounds to 2,707; in 1938, 2,249 pounds to 3,144. By fertilizing, and cutting early, the yield of protein was doubled, and the yield of hay increased by about half a ton per acre. The quality of the hay was improved greatly. The percentage of protein in the late-cut hay was 6.00, while in the early-cut, fertilized hay it was 9.13.

Whether fertilized or not, late cutting resulted in a loss of protein yield per acre. Relatively little increase in yield was obtained by permitting fertilized hay to stand until late cutting, while the quality decreased markedly.

The annual cost for fertilizer in this program was approximately $4 per acre and, as a three-year average, resulted in an additional yield of 152 pounds of protein per acre. Better hay was produced, it was lower in fiber and higher in digestible nutrients than late-cut hay from unfertilized fields; and there was about a half ton more hay per acre. During the three years of the demonstration, early-cut hay seemed to be as easy to cure as was hay cut late. In those years most of the rain fell during the later period, although during several years there is little difference, according to weather records. Results to be obtained in ordinary cutting practice with various fertilizers, have been shown by Tyson in Mich. Quarterly Bul. Vol. 19, No. 1, p. 1-8, Aug. 1936. Other fertilizers, high in nitrogen but containing other fertilizer elements for soils deficient in them, may be more economical than ammonium sulphate and better adapted to the "sour" soils of the region. In view of the results of the demonstration, it is likely that early cutting and fertilization with ammonium sulphate is a profitable practice under the agricultural conditions described, where high-nitrogen concentrates are purchased in any case, and where legume forages are scarce for winter feeding.

If one were to compare the expense over a three-year period for ammonium sulphate in fertilizing a five-acre field of quack grass (about $60) with the expense of liming and seeding to alfalfa, with the work involved in eradicating the quack grass and preparing a clean, firm seedbed, the problem takes on a slightly different aspect. It would be far more work to put in the alfalfa than to apply the ammonium sulphate. The cash outlay for the ammonium sulphate perhaps would exceed somewhat the expense for lime and seed and fertilizer for the alfalfa. The yield of hay from the alfalfa should, in one cutting, equal the yield of fertilized quack grass in one cutting. If it did, the yield of protein from the alfalfa should be almost double the protein yield from the quack grass. The soil, following the alfalfa, should be somewhat sweeter than it was before liming; and following the quack grass, somewhat "sourer" than before applying ammonium sulphate. According to feeding experiments at Michigan, Cornell, and Wisconsin, the early-cut grass hay seems to be as good a feed for dairy cows as alfalfa hay when the protein contents of the two rations are balanced by protein supplements. The expense for the ammonium sulphate is spread over three years, while for alfalfa it is concentrated in one year. The alfalfa hay is the more difficult to cure. Far more traction power

and far more agricultural skill is required to establish the alfalfa meadow. For those farmers who must avoid a "sweeter" soil, or who cannot make arrangements for suitable power and machinery to prepare a clean, firm seedbed, or who lack the skill to prepare a good seedbed, early cutting of fertilized grass meadows seems a desirable practice.

On the other hand, for those who seek a more stable means of maintaining the productivity of their fields and a forage that is of recognized superiority in livestock rations, more promise is afforded by the culture of alfalfa or suitable mixtures of alfalfa with other adapted legumes and grasses.

HOME-GROWN FARM PRODUCE USED BY THE FARM HOUSEHOLD

F. M. ATCHLEY AND H. A. BERG
SECTION OF FARM MANAGEMENT

The value of produce grown on the home farm and used by the household is an item worthy of much attention on the average Michigan farm. This is especially true on the self-sufficing farms and on the many small farms throughout the state where the home-grown produce makes up a large percentage of the actual farm income.

Records of the amounts and values of home-grown produce used by the farm family were kept in 1937 by 255 of the 1,333 farmers cooperating with the Farm Management Department in the extension project in farm accounting. Many others kept a partial record of the produce used in the home, but only complete records are included in this report. It is only logical that the amounts and prices of farm produce used in the farm household should vary in different parts of the state because of different types of farming, different types of and distances to markets, and different food consuming habits. With this in mind, the 255 farms used in this study were distributed into three groups: (1) Southern Michigan—156 farms in counties south of a line drawn between the southern boundaries of Mason and Arenac counties; (2) Northern Michigan—70 farms in the remaining northern counties of Lower Michigan; and (3) Upper Peninsula—29 farms.

The average value of the home-grown farm produce used in each household in 1937 for all 255 farms used in this study was $306.13. Similar studies were made in 1935 and in 1936, and the average values reported were slightly lower, $287.28 and $292.39, respectively. The farmers keeping the records in these studies were instructed to use farm prices to determine the value of the farm products used in the home and it was estimated that the city retail prices would be about double farm prices which would make an average of about $600 a farm. It would be incorrect, however, to use retail prices in these calculations for they include charges for transportation, commission, processing, wholesaling, and other items not logically included in farm prices. It should also be mentioned that "farm prices" are not the same on all farms even in the same section of the state because each

farmer determines his own price for each of his home-grown home-used products.

The average value of home-grown farm produce used in 1937 in each of the 156 farm households in the southern counties was $289.60. The average size of family on the 131 farms furnishing this information was 3.6 persons over 12 years of age and 1.13 children. The lowest value of products used per family was $63 for a family of 2 adults and 1 child, and the highest was $663 for a family of 5 adults.

The amounts and values of farm products used by the farm household on the 156 southern Michigan farms during 1937 are shown in Table 1. This table shows the average amounts for all families included in the report and also for just the families that used the particular item. For example, the 156 farmers used an average of 18 cords of wood valued at $32.96, but the fact that only 123 of the 156 actually used wood from their farms raised the average to 23 cords valued at $41.80 a farm. Only 75 reported the use of home-grown beef and the value was $30.19 a farm. It should be mentioned that because of a lack of comparable quantity units on several items only average values have been shown.

Table 1. The amounts and values (at farm prices) of farm products used by farm households on 156 southern Michigan farms during 1937. Average size of family, 3.6 persons over 12 years of age and 1.13 children.*

Item	Average per Farm for the 156 Farms			Average for Farms Using		
	Amount	Price	Value	Number of farms	Amount	Value
Fuel, cords	18	$1.81	$32.96	123	23	$41.80
Milk, quarts	1,273	.044	55.63	156	1,273	55.63
Cream, pints	71	.15	10.39	81	137	20.00
Butter, pounds	66	.34	22.83	80	129	44.52
Eggs, dozen	132	.22	28.69	146	141	30.66
Poultry	—	—	17.60	133	—	20.65
Beef, pounds	136	.11	14.51	75	282	30.19
Pork, pounds	255	.11	27.40	105	378	40.71
Mutton, pounds	6	.10	.63	12	86	8.17
Potatoes, bushels	29	.67	19.35	152	30	19.86
Other vegetables	—	—	19.58	133	—	22.96
Fruit	—	—	12.97	116	—	17.44
Products canned	—	—	24.94	109	—	35.69
Miscellaneous	—	—	2.12	24	—	13.75
Average per farm			$289.60			
House rent (10% of value)			213.38			

*Average size of family based upon 131 farms furnishing this information.

Table 2 shows that the farmers in the northern part of the state used larger amounts and values of home-grown products in the farm household than did those in the southern counties. The average value of products for the 70 farms was $331.63 as compared with $289.60 in the southern area. The average size of family on the 62 farms furnishing this information was 4.0 persons over 12 years of age and 1.29 children. The lowest value of produce used per family was $86 with a family of 3 adults and 1 child less than 12 years of age and the highest was $769 with a family of 8 adults.

Table 2. The amounts and values (at farm prices) of farm products used by farm households on 70 northern Michigan farms during 1937. Average size of family, 4 persons over 12 years of age and 1.29 children.*

Item	Average per Farm for the 70 Farms			Average for Farms Using		
	Amount	Price	Value	Number of farms	Amount	Value
Fuel, cords	32	$1.54	$49.47	53	42	$65.34
Milk, quarts	1,057	.043	45.19	70	1,057	45.19
Cream, pints	148	.14	21.17	58	178	25.55
Butter, pounds	147	.34	50.34	62	165	56.84
Eggs, dozen	113	.22	24.53	63	126	27.25
Poultry	—	—	15.37	61	—	17.64
Beef, pounds	126	.10	12.92	35	253	25.83
Pork, pounds	307	.10	32.01	56	384	40.02
Mutton, pounds	15	.09	1.44	8	133	12.62
Potatoes, bushels	36	.49	17.82	69	37	18.07
Other vegetables	—	—	15.90	58	—	19.19
Fruit	—	—	15.16	56	—	18.95
Products canned	—	—	27.27	54	—	35.35
Miscellaneous	—	—	3.04	14	—	15.21
Average per farm			$331.63			
House rent (10% of value)			139.63			

*Average size of family based upon 62 farms furnishing this information.

Table 2 also shows the amounts and values on the basis of all farms included in the study and also on the basis of the farms using the particular product. As would be expected, the farmers in the northern counties used much more fuel from their farms than did those in the southern part of the state. It should also be noted that the farmers in this area used much more of the cream and butter produced on their farms than did those in the southern counties. This was probably

Table 3. The amounts and values (at farm prices) of farm products used by the farm households on 29 Upper Peninsula Michigan farms during 1937.

Item	Average per Farm for the 29 Farms			Average for Farms Using		
	Amount	Price	Value	Number of farms	Amount	Value
Fuel, cords	31	$1.64	$51.41	24	38	$62.12
Milk, quarts	1,487	.041	60.59	29	1,487	60.59
Cream, pints	180	.13	23.34	19	274	35.63
Butter, pounds	107	.33	35.55	20	155	51.55
Eggs, dozen	107	.23	24.86	27	115	26.70
Poultry	—	—	12.21	21	—	16.86
Beef, pounds	143	.11	15.00	17	243	25.59
Pork, pounds	270	.13	35.17	20	391	51.00
Mutton, pounds	—	—	.48	2	—	7.00
Potatoes, bushels	32	.65	20.41	28	33	21.14
Other vegetables	—	—	18.90	24	—	22.83
Fruit	—	—	10.04	21	—	13.86
Products canned	—	—	24.14	23	—	30.43
Miscellaneous	—	—	1.45	3	—	14.00
Average per farm			$333.55			
House rent (10% of value)			157.19			

because in the northern part of the state the farms are of a more self-sufficing type and a much smaller percentage of the dairy production is removed from the farms as whole milk.

Only 29 complete records were available from the Upper Peninsula, so the statistics presented in Table 3 are less representative of this portion of the state than might be desired. The figures are significant, however, in that they may be compared with those for other sections of the state.

The average value of products used per farm was $333.55 for the 29 farms, which was slightly more than the similar figure for the northern counties of lower Michigan and about $34 more per farm than for the southern counties. The lowest value per farm was $177 for a family of 3 adults and 3 children and the highest was $693 for a family of 8 adults and 2 children. Most of the values, however, were between $200 and $400 per farm. All of the farms provided the household with milk and all but two provided eggs while only two provided home-produced mutton.

Another important item on the farm that has not been discussed is the value of the use of the farm dwelling. In the farm account book the farm dwelling is not included as a part of the farm business and, therefore, the interest, repairs, and depreciation on it are not included in the expense items. The average dwelling on the 255 farms was valued at about $1,880 and if a fair annual rental is assumed to be about 10 per cent of the value, it would be equivalent to about $188 per farm.

Economic conditions during the last few years have brought about increased interest on the part of many people in the amount of home-grown produce used by farmers' families. As well as giving total figures for the 255 farms studied for 1937, Table 4 makes it possible to compare data showing the amounts of the various products used for several recent years. It must be borne in mind that prices change from year to year and the values are, therefore, not too significant when different years are compared but they are the best available in this brief study. Significant observations from this table show that the consumption of home-produced meat has recently increased, home-produced butter and eggs have decreased slightly, and the inventory value of farm dwellings has fallen. Despite popular opinion, however, it does not appear from this table that the depression brought about a marked increase in the use of home-produced farm products.

Much of the home-grown portion of the family's food supply is produced in connection with the regular commercial crop production. In some parts of the state and on many farms, however, some of the crops are not produced on a commercial basis and, when grown at all, are grown only for home consumption. Illustrations of such products are hogs, poultry and eggs, fruit, potatoes, and dairy products. The adaptability of farmers' abilities to their resources usually determines what may best be grown on a commercial basis in different parts of the state. Commercial production of all the usual home-used products discussed in this report is not recommended for all parts of Michigan, but most of these products may be justifiably produced on a limited basis for home consumption. In most instances, a farmer will find it advantageous to produce a large proportion of the produce used by his family.

Table 4. The average amount of farm products used annually by farm households on some account keeping farms in Michigan, for seven recent years[1]

Item	1929	1930	1931	1933	1935	1936	1937	7-year average[4]
Number of records	51	97	284	278	163	239	255	1929
Fuel, cords	20	18	25	27	28	24	24	24
Milk, quarts	1,204	1,112	1,241	1,199	1,263	1,244	1,239	1,215
Cream, pints	114	123	87	113	88	92	105	103
Butter, pounds	123	94	103	99	99	96	93	101
Eggs, dozen	137	142	137	131	116	122	124	130
Poultry	$18.70	$17.42	$13.06	$11.37	$16.18	$15.06	$16.38	$15.45
Beef, pounds	79	82	101	155	140	133	134	118
Pork, pounds	272	211	228	320	293	303	269	271
Mutton, pounds	—	25	12	10	10	—	9	9
Honey, pounds	17	11	6	—	—	—	—	11
Potatoes, bushels	37	27	32	30	34	30	31	32
Other vegetables	$19.61	$19.38	$16.51	$15.13	$16.37	$14.89	$18.49	$17.20
Fruit	22.12	16.12	30.80[2]	11.02	15.02	11.84	13.24	17.17
Products canned	—	—	—	16.87	21.86	16.33	25.49	20.14
Miscellaneous	11.31	14.65[3]	1.83	3.61	4.98	2.79	2.29	5.92
Total value of products used	$372.47	$310.43	$264.02	$233.53	$287.28	$292.39	$306.13	$295.18
House rent (10% of value)	203.51	222.29	216.88	204.78	179.60	185.85	187.93	200.12

[1]Farm prices were used for each particular year.
[2]Includes both fresh and canned fruit.
[3]Includes canned fruit.
[4]Each year given equal weight.

A PRACTICABLE METHOD OF TOP-WORKING LARGE APPLE TREES

F. C. BRADFORD AND H. A. CARDINELL
SECTION OF HORTICULTURE

Top-working large apple trees has generally seemed impracticable, even when the trees are sound and vigorous, for two reasons.

The immediate difficulty inheres in the large number of branches which must be grafted, if the operation is restricted to stubs of two inch maximum.

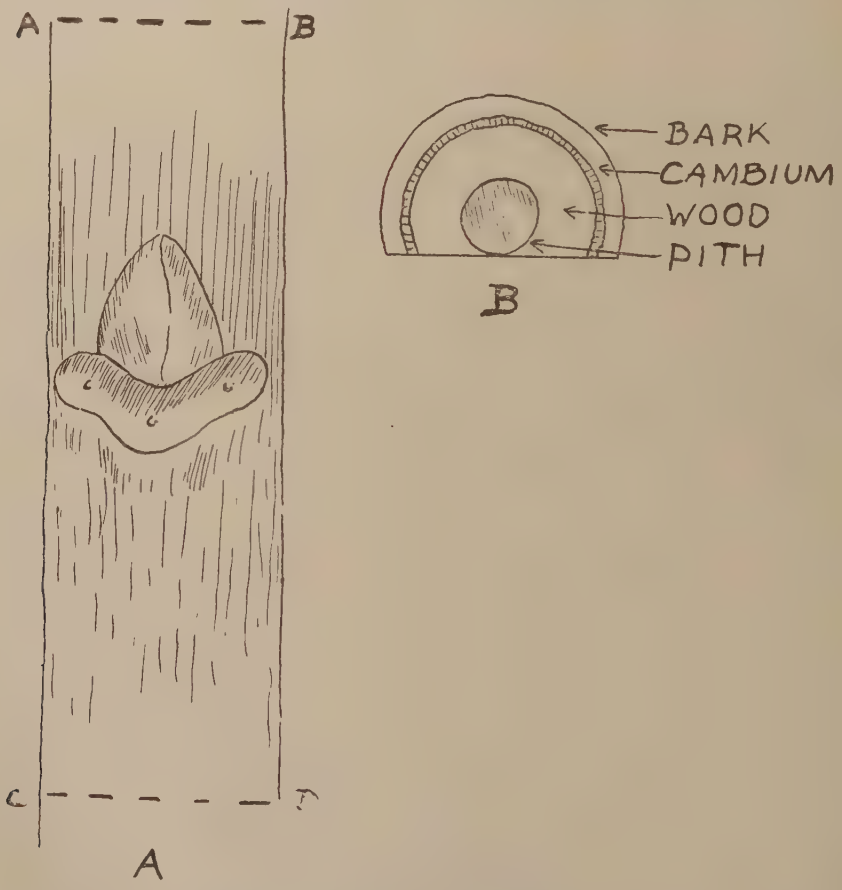

Fig. 1. Method of preparing scions. In A, the lines A-B and C-D mark the points where the scion is cut, though the scion is usually at least an inch long and may be two or more inches long and possess several buds. B shows a cross section of the prepared scion.

Fig. 2. Several scions that are starting their second year's growth. Note the slits that have been cut in the bark at the side of each scion to permit expansion from pulling the bark away from the edges of the scion.

Observations on numerous occasions and trials in the College Orchard at East Lansing have not warranted recommendation of grafting stubs larger than those of two inch diameter. Scions will grow, if set by the bark grafting method, on stubs of any size, but on large stubs they are subject to breakage by wind, and healing over is too slow to insure sound unions. Consequently, grafting large stubs in order to reduce the amount of labor involved in top-working a tree is not advisable.

Another objection to top-working large trees by the usual method lies in the fact that when the new scions begin bearing, the fruiting

area is restricted to a high outside zone, and that all shoots arising below the graft unions must be suppressed. Thus the renewal of fruiting wood is restricted.

Scrutiny of most fairly mature apple trees will reveal that most of the present crops in the best areas of the tree are borne on comparatively new wood which has grown up through the drooping older branches as the latter were pulled down by weight of fruit, never returning to their former positions. This suggests the feasibility of grafting watersprouts, thinning the top of the tree, and removing more and more of the older limbs, thus letting these grafts grow on through to the outside. Experience has demonstrated that this method is entirely practicable and that if it is followed, the total amount of grafting involved can be materially reduced and the renewal effected at a lower level.

Fig. 3. A tree topworked by the modified inlay method after a year's growth of the scions.

Fig. 4. A scion that has been set on a vertically growing limb. Note the sharp-angled crotch, an objectionable feature.

Unfortunately, watersprouts are not always available, particularly at points which would be most desirable for utilization in top-working. Furthermore, many watersprouts originate in a manner that makes them easily broken at the point of attachment.

That branches can be produced at will on most portions of scaffold limbs has been demonstrated by trials running over several years in the College Orchard at East Lansing. The operation involved resembles, superficially, patch-budding, but is probably to be considered grafting, since the technique resembles that employed in setting an inlay graft, such as often used in approach-grafting or bridge-grafting across an injury. As a matter of fact, if a bridge graft were set by the inlay method and the portion of the bridge cut away leaving only the two end pieces attached to the bark, we would have a true picture of the method herein described. It is very simple in execution and is not time-consuming.

This grafting is best done when the bark begins to slip freely (usually in May). The best scions are dormant one-year wood of the type ordinarily used in grafting; large scions are preferable, but those of ordinary size may be used. Scions are cut at points indicated by the lines A-B and C-D shown as A in Fig. 1. These scion portions may be two to six inches in length and may include one or more buds. The segment thus obtained is shaved on the side opposite the bud until the pith is barely exposed; it is practically split in half as shown in cross section as B, Fig. 1.

At the point where the graft is to be inlaid, the outer corky part of the thick bark is sliced off with a knife, leaving the "fleshy" cortical portion of the bark. On this the prepared scion is laid parallel to the

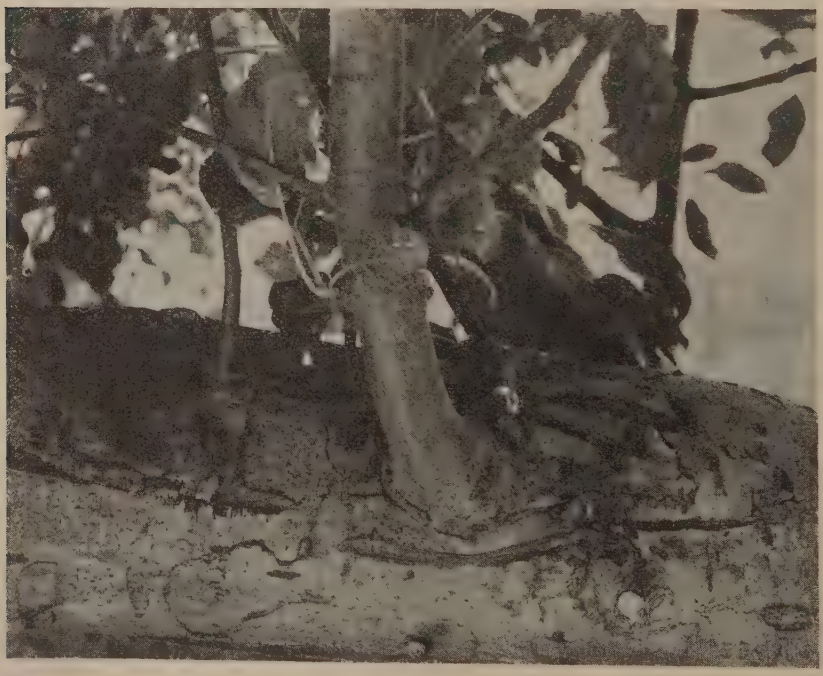

Fig. 5. A scion that was set on a horizontal limb. Note the right angle that it has made with the limb, providing an element of mechanical strength.

Fig. 6. An old tree completely topworked to Steele. All the old variety stock limbs have been removed and most of the fruiting wood has originated from scions set by the modified inlay method. About eight large watersprouts were cleft grafted to round out the job. (Photographed April 1938.)

grain of the branch and its outline marked in the bark by tracing around the scion with a knife point. Remove the scion and with the knife retrace its course, cutting down to the wood; the piece of bark is then removed and the scion inserted, with its cut face against the surface of the exposed wood. The scion is pressed and held against the surface of the wood with two small wire nails. Parallel to the scion and about two inches from it a cut is made in the bark on either side extending an inch or two beyond each end of the scion. This is to keep the expansive growth force from pulling the bark away from the edge of the scion. The entire scion is coated with grafting wax, including the cut edges of the bark surrounding the scion, but not over the parallel relief cuts to the side of the scion. Nothing further is needed.

With very little practice, an agile worker can set 25 of these inlay grafts well scattered over the scaffold limbs in an hour. Most of

them will grow the first year, but some may lie dormant a year. The total "take" of these scions, in a vigorous tree, with some of the outer branches removed, averages as high or higher than that obtained from ordinary grafting.

These scions should be placed where they can be used most advantageously in developing a new top. They should not be set on vertical or nearly vertical limbs or portions of limbs, because in such positions the growth from them often forms a narrow angled crotch (Fig. 4). They should not be placed on the exact top of diagonal or horizontal branches, because in older trees the callous formation requisite to union is slow at this point. A few degrees to the side of this top line seems to be the best location, considering both the immediate success of the grafting and the ultimate growth of the new branches.

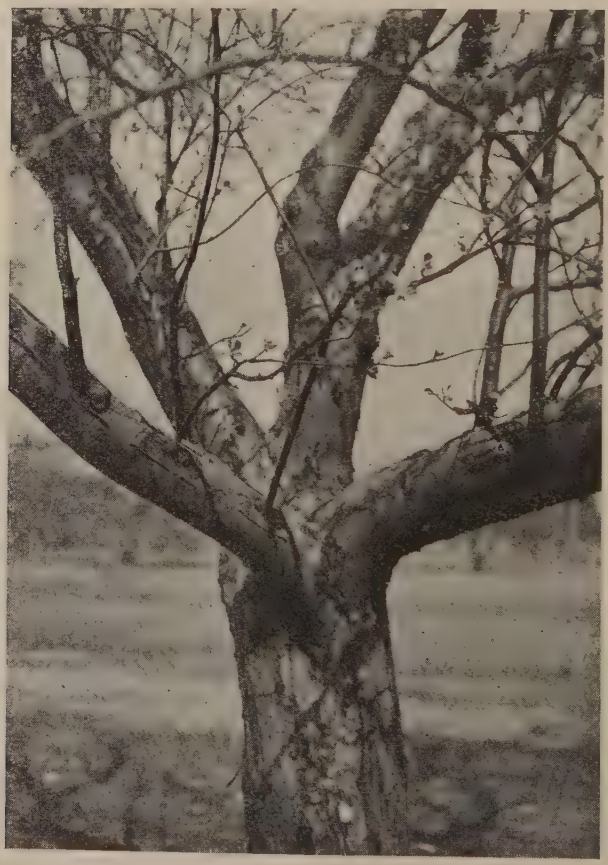

Fig. 7. A close view of the test tree, showing some of the new limbs induced by placing modified inlay grafts. The slit on either side of these limbs is the healed-over tension release slit cut on either side of each scion as described in the text. The best of these may now be saved for permanent limbs.

It is probable that in most cases a small amount of cleft grafting at the tip of each scaffold limb will be desirable to avoid leaving a stub. Desirable watersprouts should be cleft-grafted. In short, the inlay grafts should be placed where no suitable limbs remain and where new limbs are desired. The laterals, however, can be removed gradually, and replaced by the growths from the new grafts. Thus with a total expenditure of much less labor than is involved in the usual cleft grafting and with much less interruption of cropping, a rather large tree can be worked over into a tree more easily handled in later years than the one grafted high. The point should be emphasized, however, that a tree that is not vigorous is hard to top-work satisfactorily by any method.

It should be stated that limbs produced in this manner are still comparatively young, and some doubt may be raised as to whether they will tear out under the combined stress of crop, rain, sleet and wind. Present indications are that the limbs will be satisfactory, unless they are forced to inordinately rapid growth. Watersprouts which develop into fruiting branches usually are well enough anchored to withstand usual stresses, and branches from this type of graft have an anchorage in the parent more extensive than that of most watersprouts.

A final precaution should be mentioned. In renewing an old tree by any method, sun-scald is its worst enemy. If sufficient growth is not present to protect all bark on the top of main limbs, a whitewash of cold water paint should be applied to the most important scaffold branches soon after the grafting is done.

THE CRAB APPLE, COMMERCIALLY CONSIDERED

E. H. BJORNSETH
Section of Horticulture

The crab apple has been well known since the early days of Michigan's fruit industry. However, little information is available on its economic status. Some fruit growers believe that crab apple orchards are unprofitable and should be replaced by other crops. The commercial canners report that the production of crab apple jelly and preserves is declining. Though of limited interest compared with other fruits, the crab apple is grown on many farms and is a source of considerable income and this report on the marketing and production of crab apples in one fairly representative producing area is likely to be of interest to many individuals.

Method of Making Study

This study was made in Allegan County through the cooperation of the Fennville Fruit Exchange, the principal fruit marketing agency for the fruit growers of that area. Most of the data were obtained from the records of the Exchange which showed for each individual grower: (a) the grading record for each kind of fruit, (b) the washing, grading, package and packing costs, and (c) the prices for which the fruit was sold and the amounts returned to the grower for each grade.

These individual grower's records were assembled and summarized to show the total income from all fruits sold through the Exchange during 1931 to 1933, inclusive, and for the principal crab apple growers for 1934, 1935 and 1936. The gross returns obtained from the sale of apples, pears, crab apples, cherries, grapes, plums and quince for the same years were then determined. These returns were then figured in terms of percentage to show the relative importance of each fruit as a source of income. (See Table 1).

The records and the orchards of the principal crab apple growers, those whose production averaged 125 or more bushels of crab apples per year, were then selected for a more intensive study. Each grower

Table 1. Part A. Fruit Exchange's gross incomes from different fruits for the years 1931-1933.

Kind of Fruit	Year	Gross Income	Percentage
Apples	1931	$40,014.06	36.9
Pears	1931	26,635.53	24.5
Peaches	1931	15,708.99	14.5
Crab Apples	1931	5,350.30	4.9
Cherries	1931	15,606.77	14.4
Grapes	1931	1,786.45	1.6
Plums	1931	3,025.46	2.7
Quince	1931	203.80	.1
		$108,331.36	
Apples	1932	$59,501.31	46.0
Pears	1932	31,028.03	23.9
Peaches	1932	24,288.19	18.7
Crab Apples	1932	5,124.20	3.9
Cherries	1932	1,543.90	1.1
Grapes	1932	1,397.54	1.0
Plums	1932	6,260.00	4.8
Quince	1932	140.75	.1
		$129,263.92	
Apples	1933	$48,094.77	52.3
Pears	1933	22,727.07	24.7
Crab Apples	1933	4,100.30	4.4
Peaches	1933	1,882.25	2.0
Cherries	1933	5,586.15	6.0
Grapes	1933	1,000.25	1.0
Plums	1933	8,522.32	9.2
Quince	1933	8.25	.0
		$91,921.36	

The principal crab apple growers' share of the Exchange's gross income—$35,148.09 or 32.4 per cent in 1931, $52,096.23 or 40.2 per cent in 1932 and $34,303.68 or 37.3 per cent in 1933.

The percentage of gross income of the Exchange from crab apples contributed by the principal crab apple growers—$3,132.10 or 58.5 per cent in 1931, $2,655.38 or 51.8 per cent in 1932 and $2,992.00 or 72.9 per cent in 1933.

Table 1. Part B. Gross incomes from different fruits of the principal crab apple growers of the Exchange for the years 1934-1936.

Kind of Fruit	Year	Gross Income	Percentage
Apples	1934	$45,685.23	63.6
Pears	1934	17,598.97	24.5
Crab Apples	1934	3,450.50	4.8
Cherries	1934	1,916.40	2.6
Grapes	1934	638.05	.8
Plums	1934	2,476.35	3.4
Quince	1934	3.50	.01
		$71,769.00	
Apples	1935	$13,354.83	29.9
Pears	1935	20,983.18	46.3
Peaches	1935	4,911.07	10.8
Crab Apples	1935	3,408.50	7.5
Cherries	1935	1,163.87	2.5
Grapes	1935	No Data	
Plums	1935	1,484.94	3.2
Quince	1935	4.80	.0
		$45,314.79	
Apples	1936	$39,932.16	57.9
Pears	1936	16,478.65	23.9
Peaches	1936	2,667.80	3.8
Crab Apples	1936	5,617.30	8.1
Cherries	1936	2,020.52	2.9
Grapes	1936	186.00	.2
Plums	1936	2,001.62	2.9
Quince	1936	4.85	.07
		$68,908.90	

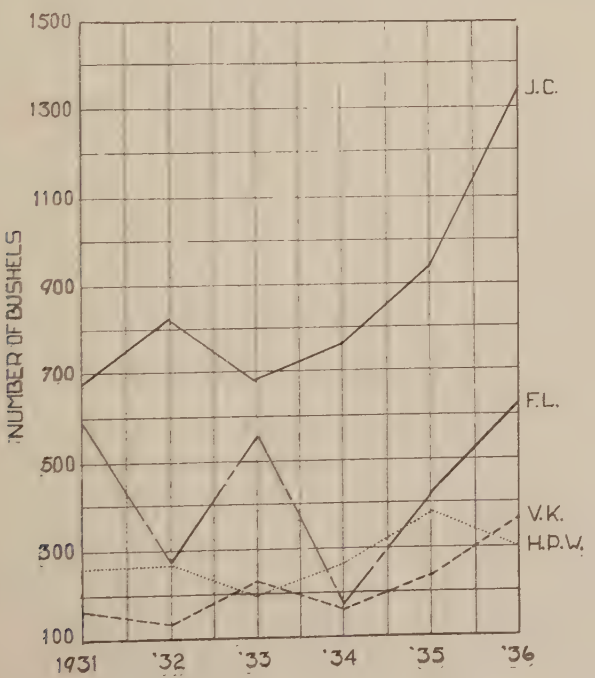

Fig. 1. Graphs showing the annual yields of certain orchards 15 to 25 years old, 1931-36 inclusive.

was interviewed to obtain information on the age and number of crab apple trees in his orchard. From these figures the average yields per tree for 1931 to 1936, inclusive, were determined. (See Table 3 and Fig. 1).

To determine how crab apples grade out as compared with other fruits, all the grading records for all fruits are summarized in Table 2.

Table 2. Comparison of grading percentages for various fruits. Fennville Fruit Exchange.

Kind of Fruit	Year	U.S. No. 1	Total All Grades	U.S. No. 1
		(bushels)	(bushels)	(per cent)
Crab Apples	1931	5,221	6,531	79.9
Apples	1931	24,752	99,087	24.9
Peaches	1931	17,953	36,204	49.5
Pears	1931	17,199	33,857	50.7
Crab Apples	1932	5,674	7,473	75.9
Apples	1932	44,098	119,062	37.0
Peaches	1932	17,004	41,399	41.0
Pears	1932	36,569	64,203	56.9
Crab Apples	1933	3,554	5,746	61.7
Apples—U. S. F	1933	17,757	95,840	37.0
Apples—U. S. No. 1	1933	17,757	95,840	37.0
Peaches	1933	807	1,323	60.9
Pears	1933	15,455	27,922	55.3
Crab Apples	1934	2,709	3,217	84.2
Apples	1934	28,243	53,539	52.7
Peaches	1934	—	—	—
Pears	1934	10,404	18,146	57.3
Crab Apples	1935*	4,550	5,165	88.0
Apples	1935	10,582	28,405	37.2
Peaches	1935	3,654	7,711	47.3
Pears	1935	13,574	19,894	68.2
Crab Apples	1936*	6,669	7,569	88.1
Apples—U. S. F	1936	112	44,282	51.4
Apples—U. S. No. 1	1936	22,657	44,282	51.4
Peaches	1936	1,454	2,271	64.0
Pears	1936	8,582	18,034	47.5

*These figures are based on the yields secured by the principal crab apple growers who are members of the Exchange.

A comparison of U. S. No. 1 crab apple prices with the price of other early competing fruits was made by recording the pool price on U. S. No. 1 crab apples, U. S. No. 1 Bartlett pears and U. S. No. 1 Wealthy apples, along with the average pool price on the various varieties of U. S. No. 1 peaches. (See Table 4).

A comparison of pool prices and production also is shown in Table 4. This table was made by taking the pool prices of U. S. No. 1 peaches, and U. S. No. 1 Wealthy apples and recording the respective total amounts of crab apples, pears, peaches, and apples produced for 1931 to 1936, inclusive. This was done to compare the prices of fruits with the local supply of these fruits. Figures 2, 3 and 4 were made to supplement the tables on production and prices and are intended to show the relation of national and Michigan production of the various fruits, such as apples, pears and peaches, to the price of crab apples. The last three years recorded on the graph represent the production of

Table 3. Individual growers' yields of crab apples per tree for a 6-year period.

Grower	Trees		1931 Yield		1932 Yield		1933 Yield		1934 Yield		1935 Yield		1936 Yield		Average Yield 1931-36
	No.	Age in 1936	Total	Per tree	Total	Per tree	Total	Per tree	Total	Per tree	Total	Per tree	Total	Per tree	
J. C.	500	20	963	1.9	1450	2.9	1172	2.3	1331	2.6	1707	3.4	2512	5.0	3.0
V. K.	118	17	166	1.3	83	.7	259	2.2	154	1.3	300	2.5	529	4.4	2.0
F. H. L.	364	20	596	1.6	363	1.0	953	2.6	190	.5	665	1.8	1048	2.8	1.7
G. M.	350	30	424	1.2	452	1.2	415	1.2	534	1.5	446	1.2	646	1.8	1.3
O. P.	75	25	170	2.2	131	1.7	218	2.9	247	3.2	153	2.0	381	5.0	2.8
E. W.	200	15	336	1.6	495	2.4	—	—	—	—	—	—	—	—	2.0
S. W.	175	15	190	1.0	296	1.6	—	—	—	—	—	—	—	—	1.3
H. P. W.	81	20	336	4.1	364	4.4	203	2.5	360	4.4	594	7.4	419	5.1	4.6
F. L.	50	20	85	1.7	115	2.3	122	2.4	133	2.6	147	2.9	210	4.2	2.6
E. R.	98	12	132	1.3	46	.5	—	—	—	—	—	—	—	—	.9
R. V.	30	30	137	4.5	91	3.3	41	1.3	139	4.6	—	—	93	3.1	3.6
E. L.	125	20	161	1.2	210	1.6	190	1.5	335	2.6	279	2.2	451	3.6	2.1
T. G.	152	28	143	.9	543	3.5	357	2.3	727	4.7	506	3.3	966	6.3	3.5
Average				1.8		2.0		2.1		2.8		2.9		4.1	2.6

Average annual yield for 6 years—2.6 bushels.

Table 4. Average prices received for crab apples and some of the competing fruits, Fennville Fruit Exchange.

Year	Average Crab Apple Prices	Crab Apple Produced (bushels)	Average Bartlett Prices	Pears Produced (bushels)	Average Peach Prices	Peaches Produced (bushels)	Average Apple Prices	Apples Produced (bushels)
1931	$0.85	6,531	$0.68	33,857	$0.80	36,204	$0.85	99,087
1932	1.00	7,473	1.40	64,203	.70	41,399	.70	119,062
1933	1.00	5,746	1.50	27,922	1.80	1,323	.60	95,840
1934*	1.30	3,217	1.60	18,146	no crop	no crop	1.15	53,539
1935*	.70	5,165	1.50	19,894	1.00	7,711	.80	28,405
1936*	.80	7,569	1.50	18,034	1.35	2,271	1.00	44,282

*These figures are for the principal crab apple growers in the Exchange and not for the entire membership.

the orchards of the principal crab apple growers and not the entire membership of the Exchange.

The costs per bushel for washing, handling, grading and package for crab apples were obtained from the Fennville Fruit Exchange accounts. The cost per bushel for picking was determined from the daily wage rate and the average amounts picked by one man per day. These charges are shown in Table 5.

The marketing costs recorded in Table 5 were transferred to Table 6, along with the price received per bushel of crab apples and the average

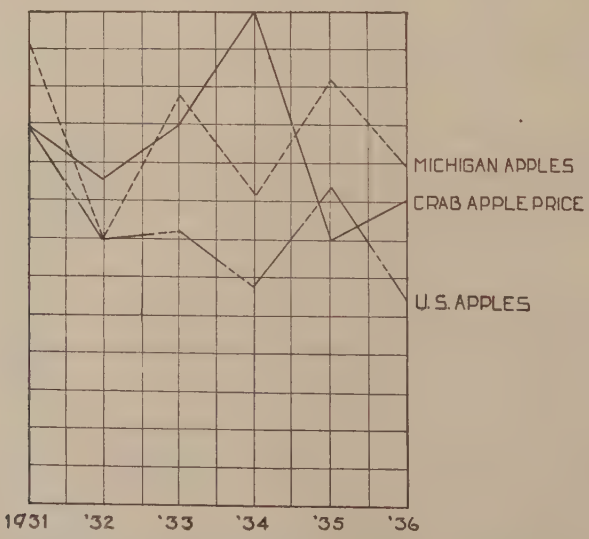

Fig. 2. Graphs showing total U. S. production of apples, total Michigan apple production and the local crab apple prices, 1931-36 inclusive. (Each square represents: 20,000,000 bushel production on the U. S. apple curve, 800,000 bushel production on the Michigan apple curve and 10 cents on the crab apple price curve.) (The production figures were obtained from Yearbook of Agriculture.)

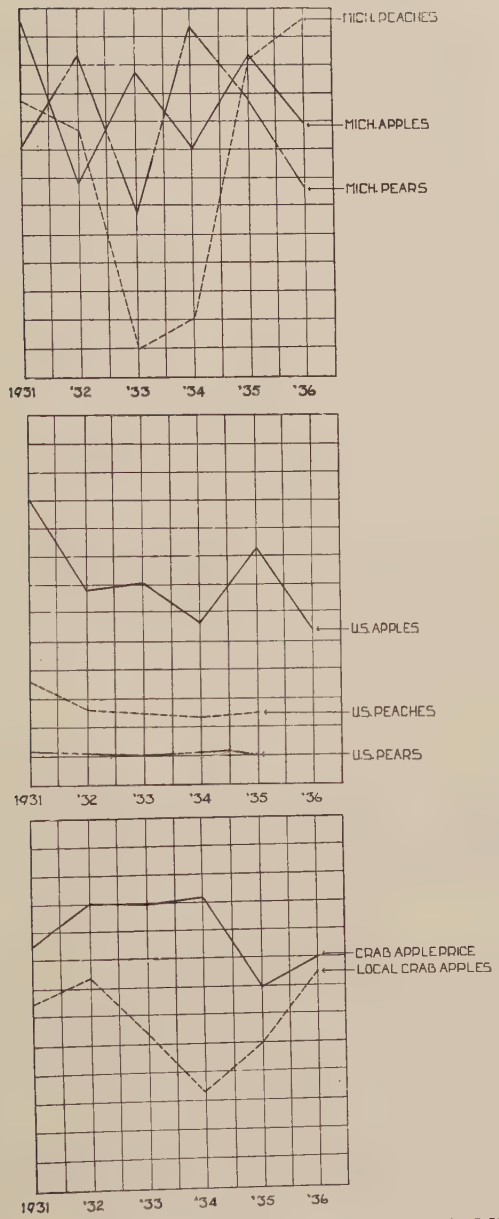

Fig. 3. Graphs showing United States and Michigan production of apples, pears, peaches and crab apples and local crab apple prices. (Each square represents: 20,000,000 bushel production on the U. S. apple, peach and pear curves, 800,000 bushel production on the Michigan apple curve, 200,000 bushel production on the Michigan peach curve, 60,000 bushel production on the Michigan pear curve, 1,000 bushel production on the local crab apple curve, 10 cents on the crab apple price curve.) (The production figures were obtained from Year-book of Agriculture.)

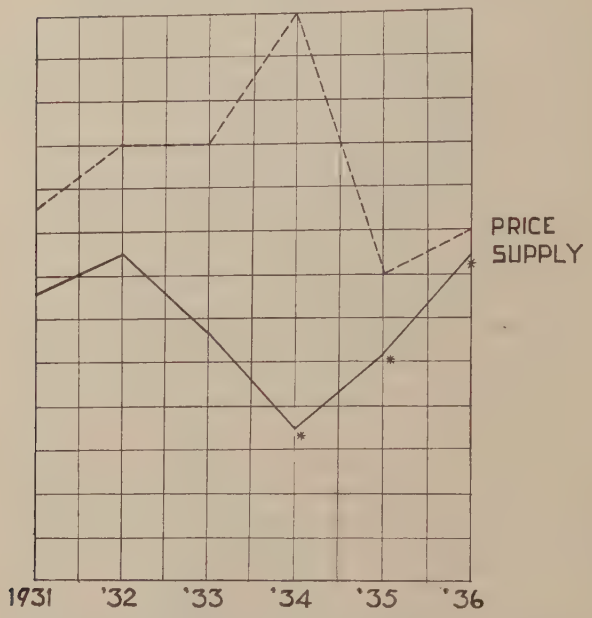

Fig. 4. Graphs showing the relation of crab apple prices to the local supply of crab apples. (Each square represents: 1,000 bushel production on the supply curve, 10 cents on the price curve.)

annual yield per tree to obtain information on the return per tree and per acre from crab apple orchards. The return per tree and the return per acre are figured as the difference between gross income for these units and the marketing costs. Production costs such as for pruning, spraying, cultivating and thinning have not been accounted for in these returns.

Presentation of Data

Total Returns and Relative Importance—The relative commercial importance of the crab apple in the Fennville section, as determined from data collected from the records of the Fruit Exchange, was fifth among the kinds of fruit handled by this Exchange. The gross income from crab apples was 4.4 per cent of the total gross income from the

Table 5. Annual packing and handling costs per bushel, Fennville Fruit Exchange.

	1931	1932	1933	1934	1935	1936
Washing	$0.01	$0.01	$0.01½	$0.01½	$0.02	$0.02½
Handling and Grading	.08	.07	.06	.06½	.06½	.07
Package	.17	.15	.15½	.19	.17	.17
Picking	.07½	.06	.10	.10	.12	.12
Total Charge	$0.33½	$0.29	$0.33	$0.37	$0.37½	$0.38½

Table 6. Total marketing costs, prices received, amount left, yield per tree, and the return per acre, for the years 1931 to 1936. These data are for the orchards of the principal crab apple growers in the Fennville area.

Year	Total Handling and Marketing Costs per Bu. U.S. No. 1	Price Received per Bu. U.S. No. 1	Amount Left per Bu. U.S. No. 1	Yield per Tree U.S. No. 1 (bushels)	Income Return per Tree U.S. No. 1	Yield per Tree Culls (bushels)	Price per Bu. Culls	Income Return per Tree Culls	Total Return per Tree	Return per Acre 50 Trees
1931	$0.335	$1.00	$0.665	1.4	$0.95	.4	$0.10	$0.04	$0.99	$49.50
1932	.29	.85	.56	1.5	.84	.5	.15	.07	.91	45.50
1933	.33	1.00	.67	1.3	.87	.8	.25	.20	1.07	53.50
1934	.37	1.30	.93	2.0	1.86	.8	.45	.36	2.22	111.00
1935	.375	.70	.33	2.1	.69	.8	.25	.20	.89	44.50
1936	.385	.80	.43	3.0	1.29	1.1	.25	.27	1.56	78.00
Average	$0.345	$0.94	$0.595	2.2	$1.08	.7	$0.24	$0.19	$1.27	$63.66

NOTE:—The above returns per acre and per tree are figured as the difference between gross income and marketing costs. Production costs such as spraying, cultivation, pruning, etc. have not been subtracted.

sale of all kinds of fruit by this marketing organization (Table 1). The figures in part A of this table show the gross returns from the various kinds of fruits sold by the entire membership of the Exchange for the years 1931 to 1933, inclusive, when the members numbered 79, 75 and 61, respectively. Part B of Table 1 shows the returns of the principal crab apple growers of the Exchange from the various fruits which they produced. These leading crab apple growers were also the largest growers of other fruits, having received 36.6 per cent of the gross returns of the Exchange for the period of 1931 to 1933 and 61 per cent of the gross returns from crab apple sales for this same period. This same group of growers, 16.9 per cent of the Exchange membership, with the larger incomes received 6.8 per cent of their total gross revenue from their orchards for the years 1934 to 1936 from the sale of crab apples. One of them with a gross income varying from $10,000 to $12,000 annually received 12 per cent of this total gross income from the sale of crab apples.

Table No. 1 shows that none of the other fruit crops raised in the Fennville area yielded as regular an income year after year as crab apples. Peaches, cherries, grapes and plums, in the order named, were the least stable as sources of income. This fluctuation in annual returns from these different fruits may be attributed to severe winters and attendant winter injury to trees or their flower buds, to spring frosts, to a marked tendency toward biennial bearing, and to low prices during the years of heaviest production. Crab apples are hardy and may be depended upon more than any of the other fruits to produce more even sized crops year after year.

Grading Records—One of the characteristics of crab apples as a fruit crop is their relatively high grading percentage. A comparison of the grading percentages for crab apples, apples, pears and peaches, as given in Table 2, shows that crab apples grade out the best of those four fruits. The percentage of U. S. No. 1 crab apples was 72.5 for the entire membership of the Exchange for the years 1931 to 1933, inclusive, while for the principal crab apple growers of the Exchange for the years 1934 to 1936, inclusive, it was 86.7. The average grading percentage for pears was 55.9, peaches 52, and for apples, 40, during this same period.

The high grading percentage for crab apples may be attributed in considerable part to the rather uniform size of the fruit. It was observed that very few crab apples were culled for lack of size. The Hyslop variety is also known for its good color. Furthermore, it is the writer's opinion that it is easier to produce crab apples free from scab and worm injury than other tree fruits because of the slower rate at which the fruit grows, thereby increasing the effectiveness of fungicides and insecticides. The amount of spray residue on crab apples is probably greater than the amount of spray residue on other fruits. This supposition is supported somewhat by the concern of some growers as to whether their crab apples will pass the tolerance test for arsenic and lead for marketable fruit. Some growers make a rough estimate of the amount of spray residue on their other varieties of apples by the amounts of lead and arsenic found on crab apples. Growers believe that if their crab apples are below the tolerance limit

for these spray materials their other varieties of apples will also be below that tolerance limit.

Yields—Yields of crab apples produced in the orchards included in this study are shown in Table 3. As would be expected, there is much variation. For instance, the crab apple trees in the orchard of H. P. W. consistently out-yielded the trees belonging to G. M. This difference may be attributed to the difference in the methods practiced by the two growers. The annual yields of crab apples for the orchards of the principal growers showed a gradual increase as the trees became older, some of which probably was due to the growth of the tree, some to climatic and other factors. In 1936, the last year for which yields were recorded, most growers obtained relatively large yields. The average yield for that year was 4.1 bushels per tree, while the lowest yield was obtained in 1931 with an average of 1.8 bushels per tree. One grower obtained as large a yield of fruit from trees 7 years old as a number of other growers obtained from trees ranging in age from 10 to 30 years. A yield of 23 bushels was obtained from one 35-year-old tree in the orchard of a grower who was not a member of the Exchange. Individual crab apple trees often show more or less of a biennial habit of fruiting and this may extend to entire orchards. This is shown in the slight alternation of somewhat larger and somewhat smaller yields of the orchards for which records are presented in Table. 3.

Prices—A study of the prices of crab apples and other fruits going on the market at about the same time shows that crab apple prices are more or less independent of the prices received for other fruits (see Table 4), though it is evident that crab apple prices follow somewhat those of the other fruits. Perhaps the most noticeable feature about them is that they show less extreme variation from year to year.

The price of crab apples in any one year shows some relation both to the annual production of apples in the United States and in Michigan. Figure 2 shows that this was more evident during the period of 1933 to 1936, inclusive, than during the period 1931 to 1933. Figure 3, showing the production of apples, pears, and peaches for Michigan and the United States, along with crab apple prices, indicates very little relationship between crab apple prices and the production of pears and peaches in the United States or Michigan, while the price of crab apples shows a tendency to vary inversely with the total apple production in the United States.

Local production of crab apples apparently has very little effect on their price (see Figure 4). The first three years recorded on the graph are for the production of the entire membership of the Exchange, while the last three years are for that of the principal crab apple grower. However, the principal crab apple growers produced 61 per cent of the crab apples sold by the Exchange and for this reason the production of crab apples for the entire membership would be considerably greater than that recorded for the last three years. Nineteen thirty-six was the year of the greatest local production, yet the price was 10 cents per bushel higher than the year before. The annual local production of crab apples will vary between 5,000 and 8,000 bushels per year and apparently that amount is too small to have any considerable influence on the price of crab apples in the midwest markets.

Marketing Costs—The marketing and production costs for crab apples vary from year to year. The charge for washing varied from 1 to 2½ cents per bushel. During 1936 early apples were washed for the minimum rate of 2 cents per bushel, while late varieties of apples, including crab apples, were washed for the maximum rate of 2½ cents per bushel.

The handling and grading charge varied from 6 cents per bushel in 1933 to 8 cents per bushel in 1931. The price of the package varied from 15 cents in 1932 to 19 cents per bushel in 1934. The cost of picking ranged from 6 cents per bushel in 1932 to 12 cents per bushel in 1936. The higher cost of picking in 1936 was due principally to an increase in the wages of the pickers, rather than to a lighter crop and a greater amount of time required to harvest a bushel of fruit.

The total marketing cost was the lowest in 1932, with a charge of 29 cents per bushel for these various services, while in 1936 it was the highest, with a charge of 38½ cents per bushel of crab apples.

Returns—The average yields of U. S. No. 1 crab apples and culls produced per tree, together with the various packing and handling costs and prices per bushel for these grades, were used in determining the income per tree and per acre of 50 trees. It will be noted (Table 6) that the net income per acre before subtracting overhead and current orchard maintenance costs, of crab apples varied from $44.50 in 1935 to $111.00 in 1936. The average return for the six-year period was $63.66 per acre.

Discussion

The raising of orchard fruits in Michigan involves much financial risk. The grower who depends upon only one or two kinds as the principal source of income is accepting more risk than the grower who raises a greater diversity. The production of crab apples on the average fruit farm provides a means of spreading and minimizing this financial risk. On the other hand, the demand for crab apples is about the same year after year; for this reason, it is not advisable greatly to increase the acreage. New plantings should be limited for the most part to replacements of those trees taken out of production.

Summary

1. Though crab apples are a minor fruit crop, they are a popular supplementary fruit crop in the Fennville district of Michigan, 70 per cent of the growers raising them for income.
2. The production of crab apples is about stationary.
3. In comparison with other fruits crab apples are easily grown, as shown by their high grading percentage.
4. Crab apples sell for prices comparable to those paid for apples, but their prices are subject to less fluctuation than those of most other fruits.
5. The trees yield reasonably well and more regularly than those of most apple varieties.
6. The fruits grade considerably better than those of the apple, seldom showing size or color deficiency.
7. Average net returns per tree or per acre are reasonably satisfactory.

CHERRY PRODUCTION COSTS FOR EIGHT MICHIGAN ORCHARDS, 1935-1937

G. N. MOTTS
SECTION OF ECONOMICS

Source of Data—The data on cherry production costs presented in this paper were obtained in connection a study of cherry tree mortality recently completed*. The cost figures were obtained from eight Michigan cherry growers who have for several years cooperated with the Farm Management Department of the college in the Farm Account project. These growers supplied the necessary data from their farm account books and the fruit supplements used in recent years. Though the limited number of orchards included in this paper is not sufficient to indicate accurately an average cost of production for cherries in Michigan, the available cost data for these eight orchards may be of interest until a comprehensive study might be made comparable to the one recently published on apple production costs in Berrien County by Wright and O'Brien**.

The location, acreage and production of red cherries*** in each of the eight orchards are shown in Table 1. The plantings ranged in size from 1.4 to 21 acres of bearing trees of the Montmorency variety and were located as follows: three in the southern Michigan cherry area, two in the central area and three in the Grand Traverse region. All the data apply to the bearing acreage only.

The available data in regard to labor, power and spray materials used per acre for these orchards are presented in Table 2. Since cherry pickers are paid by the pound, no records of man-hours of labor for this operation were available.

Computation of Production Costs Per Acre—The costs of cherry production for these eight Michigan orchards have been classified in this paper in the same manner as that used in the study of apple production costs in Berrien County.

The cost figures for cash expenditures and receipts are the total amounts shown in the farm account books reduced to the cost per acre, while the non-cash costs have been computed from the records of man-hours, tractor-hours, etc. The rates used per man-hour were 20 cents for 1935 and 25 cents for 1936 and 1937; power costs of 10 cents per horse-hour in 1935 and 12 cents in 1936 and 1937, and a rate of 60 cents per tractor-hour for the light two-plow size and 75 cents per hour for the heavy two-plow tractors for each of the three years. The cost of trucking the cherries to market was based on a rate of 7 cents

*Motts, G. N. "Cherry Tree Mortality in Six Michigan Counties, 1930-1938." Mich. Agr. Exp. Sta. Quar. Bul. Nov., 1938.

**Wright, K. T. and O'Brien, W. R. "Cost of Producing Apples in Berrien County, Michigan, 1935." Mich. Agr. Exp. Sta. Spec. Bul. 286. 1937.

***The term "red" cherry has come into use recently to replace "sour" cherry, a term regarded as a handicap to the industry by cherry growers and canners.

Table 1. Location, acreage and production of eight Michigan cherry orchards.

Year	Grower number	County	Bearing acreage	Number of Trees				Production (lbs.)		
				On farm		Per acre				
				B	N–B	B	N–B	Total	Per acre	Per tree
1935	1	Grand Traverse	21	2,100	150	100	100	157,250	7,488	75
	2	Oceana	14	1,150	500	82	82	8,685	620	*
	3	Antrim	10	966	—	97	—	43,458	4,346	45
	4	Oceana	9	922	490	102	98	16,709	1,857	18
	5	Grand Traverse	6	636	1,378	106	106	43,105	7,184	68
	6	Berrien	3.4	340	—	102	—	4,050	1,191	12
	7	Berrien	2	204	—	102	—	8,924	4,462	48
	8	Berrien	.4	40	—	100	—	—	No Record	
1936	1		—	—	—	—	—	98,079	4,670	47
	2		—	—	—	—	—	10,025	716	9
	3		—	—	—	—	—	42,338	4,234	44
	4		—	—	—	—	—	52,328	5,814	57
	5	As in 1935	—	—	—	—	—	28,135	4,689	44
	6		—	—	—	—	—	250	—	—
	7		—	—	—	—	—	3,350	1,675	16
	8		—	—	—	—	—	1,501	3,752	38
1937	1		—	—	—	—	—	97,000	4,619	46
	2		—	—	—	—	—	17,105	1,222	15
	3		—	—	—	—	—	36,046	3,605	37
	4		—	—	—	—	—	31,584	3,509	34
	5	As in 1936 except for Grower No. 8—		—	—	—	—	45,974	7,662	72
	6		—	—	—	—	—	20,497	6,028	60
	7		—	—	—	—	—	26,000	13,000	127
	8		1.4	140	—	100	—	9,050	6,464	65

*Less than one pound per tree.

Table 2. Labor, power and spray used per acre for eight Michigan cherry orchards, 1935-37.

Year	Grower No.	Bearing Acreage	Man-hours						Horse-hours					Tractor-hours					Truck Miles Marketing	Spray Used	
			Pruning	Fertilizing	Cultivating	Spraying	Marketing	Total (except picking)	Pruning	Fertilizing	Cultivating	Spraying	Total (except picking)	Pruning	Fertilizing	Cultivating	Spraying	Total (except picking)		gallons	
																				Total	Per Tree
1935	1	21	21.40	1.65	4.75	14.30	11.90	54.00	—	—	—	—	—	1.81	.57	4.76	4.76	11.90	88	20,000	9.52
	2	14	5.70	.35	4.30	5.80	1.80	17.95	.57	—	7.00	5.71	13.28	—	—	.71	—	.71	5	6,000	4.28
	3	10	10.00	3.50	2.50	7.00	4.00	27.00	—	—	—	—	—	—	—	2.50	3.50	5.00	17	7,500	7.50
	4	9	13.90	.55	13.35	7.20	11.10	46.10	2.00	.56	13.33	7.00	22.89	—	—	—	—	—	10	4,800	5.33
	5	6	5.00	3.35	13.35	2.50	10.00	34.20	—	8.33	10.00	—	18.33	—	—	16.67	3.33	20.00	14	1,000	.67
	6	3.4	8.80	1.45	2.95	2.95	1.45	17.60	—	—	—	—	—	—	—	3.53	4.71	8.24	4	3,500	10.29
	7	2	10.00	5.00	10.00	10.00	15.00	50.00	4.00	4.00	20.00	18.00	46.00	—	—	—	—	—	36	No Record	
	8	.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	No Record	
1935 Average.....			10.69	2.26	7.31	7.11	7.89	35.26	—	—	—	—	—	—	—	—	—	—	25	8,133	6.43
1936	1	21	16.96	1.72	5.32	11.80	8.56	44.36	—	—	—	—	—	1.33	.25	5.25	4.29	11.12	48	20,000	9.52
	2	14	—	—	—	4.28	2.28	6.56	—	—	—	4.44	4.44	—	—	—	—	—	5	4,650	3.32
	3	10	12.00	3.20	3.20	8.00	3.80	30.20	—	—	—	—	—	—	1.00	3.00	4.00	8.00	17	9,000	9.00
	4	9	—	1.16	2.36	3.52	24.88	31.92	2.22	.56	13.67	7.67	24.12	—	—	—	—	—	22	6,400	7.11
	5	6	4.68	3.32	11.33	2.68	10.00	32.01	—	9.17	8.33	—	17.50	—	—	16.67	4.17	20.84	17	1,200	2.00
	6	3.4	—	1.16	2.36	3.52	*	*7.04	—	—	—	—	—	—	—	3.53	4.71	8.24	*	4,000	1.18
	7	2	10.00	4.00	10.00	8.00	4.00	36.00	4.00	4.00	20.00	18.00	46.00	—	—	—	—	—	21	No Record	
	8	.4	4.00	30.00	4.00	4.00	2.00	44.00	—	—	4.28	6.43	10.71	—	—	—	—	—	36	450	11.25
1936 Average.....			5.96	5.57	4.82	5.72	7.85	29.92	—	—	—	—	—	—	—	—	—	—	24	6,529	6.20
1937	1	21	24.40	5.72	4.56	16.76	9.52	60.96	—	—	—	—	—	2.00	1.00	4.52	5.71	13.23	65	22,000	10.48
	2	14	—	.28	—	3.72	2.88	6.88	—	—	—	3.71	3.71	—	—	—	—	—	7	3,900	2.78
	3	10	20.00	4.80	3.20	8.00	4.40	40.40	—	—	—	—	—	—	1.50	3.00	4.00	8.50	19	8,375	8.38
	4	9	13.76	.44	4.44	3.56	16.88	39.08	—	—	—	—	—	1.11	.44	4.67	3.33	9.55	14	6,400	7.11
	5	6	8.00	4.00	14.00	2.68	14.68	43.36	—	13.33	8.33	—	21.66	—	—	16.67	5.00	21.67	24	1,300	2.17
	6	3.4	9.40	1.16	2.36	4.72	5.88	23.52	—	—	—	—	—	—	—	3.53	4.71	8.24	12	5,050	1.48
	7	2	10.00	4.00	10.00	8.00	16.00	48.00	4.00	4.00	20.00	18.00	46.00	—	—	—	—	—	50	No Record	
	8	1.4	11.44	8.56	14.28	11.44	14.28	60.00	—	—	14.28	21.42	35.70	—	—	—	—	—	41	1,500	10.71
1937 Average.....			12.12	3.62	6.60	7.36	10.56	40.26	—	—	—	—	—	—	—	—	—	—	29	6,932	6.16
3 Year Average....			9.54	3.88	6.20	6.71	*8.85	*36.07	—	—	—	—	—	—	—	—	—	—	26	6,851	6.25

*No crop in this orchard in 1936; thus figures are omitted from the averages for items directly dependent on yield.

per truck-mile. Barnyard manure was charged at $2.50 per ton applied on the field, but distributed over a four-year period: 40 per cent for the first year, 30 per cent for the second, 20 per cent for the third and 10 per cent for the fourth year following its application. In the case of commercial fertilizer the full cost was charged to the single crop for which it was applied. The cost of equipment includes depreciation, repairs, interest on the investment at 5 per cent, fuel and oil, and shelter. For equipment used for other farm enterprises also, the cost is apportioned to the bearing acreage of cherries according to the proportion of its total use there.

The overhead costs were computed in the following manner. The cherry orchard share of the general farm expenses was set at 5 per cent of the total growing, harvesting and marketing costs. These expenses include such items as the farm share of the auto and telephone, labor on miscellaneous jobs, interest and taxes on land in roads, lanes, farmstead, ditches and fences, upkeep of fences and all other miscellaneous expenses that cannot be allocated to some specific enterprise. Complete cost accounts indicate that the foregoing rate is comparable with each farm enterprise's share of these expenses. The farm taxes are pro-rated to the orchard in proportion to the orchard value as a part of the total farm value, rather than upon an acreage basis. Interest on the value of the trees and the land is figured at 5 per cent. The land and trees were valued separately. The value of the trees was estimated by the growers and was intended to approximate the cost of growing the trees to their present age. This appreciation may be from 50 cents to $1 per tree annually until the trees are 10 years old. The value was then considered at that figure for the next five years, after which a depreciation charge of $1 annually was made until the trees were 20 years old. The specific figure used for the annual appreciation in value depends upon the owner's judgment; depending upon soil and climatic factors.

Costs of Production up to Harvesting—The costs of production per acre up to harvesting, computed in the manner previously described, for the eight Michigan Montmorency cherry orchards for the three years 1935 to 1937 are presented in Table 3.

Table 3 includes the annual average costs and the average of the group of orchards for the three-year period, while the last two lines indicate the proportion of the costs up to harvesting and of the total production costs, respectively, that are represented by each of the items in this group of costs. These costs for the orchards included in Table 3 were not greatly different from those for four other Montmorency orchards in Michigan recently cited by Gardner*. The average costs up to harvesting of the orchards in Table 2 were $28.80, $30.56 and $40.58 for the three years, while the average of the four reported by Gardner was $38.65. The costs up to harvesting for the orchards included in Table 3 amounted to 33 per cent of the total production costs.

Harvesting and Marketing Costs—The combined costs of harvesting and marketing the cherry crop amounted to 37 per cent of the total

*Gardner, V. R. Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan. Mich. Agr. Exp. Sta. Spec. Bul. 275. 1936.

Table 3. Cherry costs of production per acre, up to harvesting for eight Michigan orchards, 1935-1937.
(dollars and cents)

Year	Grower Number	Bearing Acreage	Labor				Fertilizer and Manure	Spray Materials	Use of Equipment	Power and Miscellaneous	Total
			Pruning	Fertilizing	Cultivating	Spraying					
1935	1	21	4.28	.33	.95	2.86	11.71	4.28	13.33	12.05	49.79
	2	14	1.14	.07	.86	1.16	.71	1.86	12.14	1.78	19.72
	3	10	2.00	.70	.50	1.40	6.20	3.90	6.70	3.60	25.00
	4	9	2.78	.11	2.67	1.44	2.00	5.22	11.11	5.11	30.44
	5	6	1.00	.67	2.67	.50	2.67	.83	6.33	5.34	20.01
	6	3.4	1.76	.29	.59	.59	1.18	3.82	.59	2.36	11.18
	7	2	2.00	1.00	2.00	2.00	14.00	19.00	1.00	4.50	45.50
	8	.4	—	—	—	—	—	—	—	—	No Record
1935 Average			2.14	.45	1.46	1.42	5.50	5.56	7.31	4.96	28.80
1936	1	21	4.24	.43	1.33	2.95	5.19	10.81	13.10	15.00	53.05
	2	14	—	—	—	1.07	—	1.43	11.87	.43	14.80
	3	10	3.00	.80	.80	2.00	6.50	4.70	7.50	4.80	30.10
	4	9	3.44	.11	3.44	1.89	2.67	6.22	11.11	5.22	34.10
	5	6	1.17	.83	2.83	.67	3.33	1.00	6.83	5.67	22.33
	6	3.4	—	.29	.59	.88	1.18	4.41	.59	2.65	10.59
	7	2	2.50	1.00	2.50	2.00	14.00	19.00	1.00	5.50	47.50
	8	.4	1.00	7.50	1.00	1.00	—	6.00	12.50	3.00	32.00
1936 Average			1.92	1.37	1.56	1.56	4.11	6.70	8.06	5.28	30.56
1937	1	21	6.10	1.43	1.14	4.19	7.05	11.90	14.05	22.19	68.05
	2	14	—	.07	—	.93	1.64	1.57	11.43	.36	16.00
	3	10	5.00	1.20	.80	2.00	10.50	4.30	10.60	5.10	39.50
	4	9	3.44	.11	1.11	.89	3.33	3.89	11.11	8.56	32.44
	5	6	2.00	1.00	3.50	.67	4.17	2.00	7.67	6.00	27.01
	6	3.4	2.35	.29	.59	1.18	1.76	5.59	.59	3.24	15.59
	7	2	2.50	1.00	2.50	2.00	14.00	19.00	1.00	5.50	47.50
	8	1.4	2.86	2.14	3.57	2.86	33.57	20.00	3.57	10.00	78.57
1937 Average			3.03	.91	1.65	1.84	9.50	8.53	7.50	7.62	40.58
3-Year Average			2.37	.93	1.56	1.61	6.41	6.99	7.64	6.00	33.51
Per cent of Growing costs			7	3	4+	4+	19	21	23	18	100
Per cent of Total costs			2	1	1+	1+	6	7	8	6	33

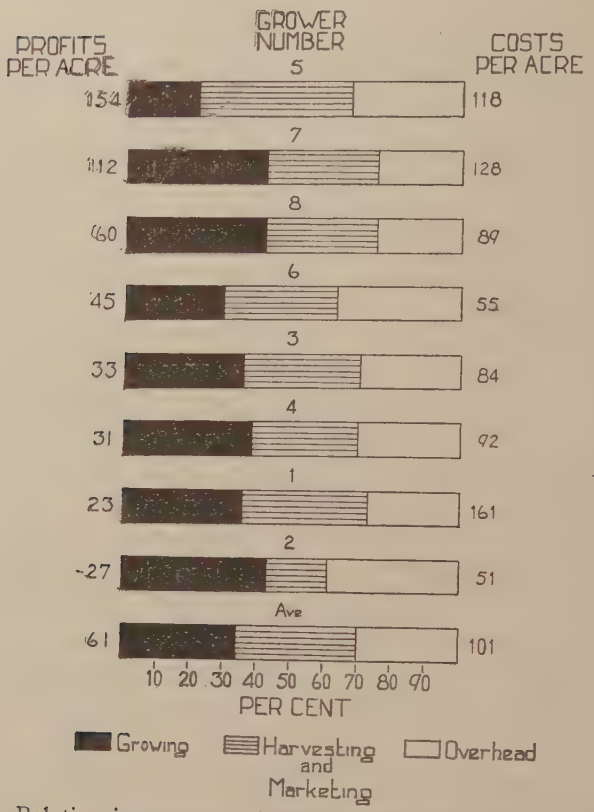

Fig. 1. Relative importance of major production costs for eight Michigan cherry orchards, 1935-37.

costs for the eight orchards, as shown in Table 4. The picking charge greatly predominates in this group of costs since the cherries are nearly all sold to nearby canners, thus largely eliminating package costs and keeping the transportation cost low.

Overhead Costs—The overhead costs per acre amounted to 30 per cent of the total production costs for the eight orchards. The predominant overhead cost is the interest charged on the value of the trees, which amounted to 59 per cent of the overhead costs or 16 per cent of all costs of production. With two exceptions, the amounts reported for tree depreciation per acre were considerably lower than those presented in the study by Gardner*, and are probably too low to be representative of the state as a whole. It is largely for this reason that the three-year average overhead costs for the orchards in Table 4 was $30.50 per acre compared with $73.70 for the orchards mentioned in the other study.

In order to compare more readily the relative importance of each of the three groups of costs and their variations among the individual

*Gardner, V. R. Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan. Mich. Agr. Exp. Sta. Spec. Bul. 275. 1936.

Table 4. Cherry costs of production, per acre, for harvesting and marketing and overhead for eight Michigan orchards, 1935-1937.

(dollars and cents)

Year	Grower Number	Bearing Acreage	Harvesting and Marketing					Overhead					
			Labor		Pkgs.	Truck or horse	Total	Share farm expenses	Taxes	Interest		Depr. of trees	Total
			Picking	Marketing						on trees	on land		
1935	1	21	58.80	2.38	4.14	6.19	71.51	6.05	2.62	28.57	5.24	—	42 48
	2	14	4.64	.36	—	.36	5.36	1.21	.57	7.64	.71	—	10.13
	3	10	2.83	.80	—	1.20	4.83	2.80	1.80	14.80	1.50	—	20.90
	4	9	13.89	2.22	—	.67	16.78	2.33	2.78	10.56	1.56	2.22	19.45
	5	6	53.83	2.00	—	1.00	56.83	3.83	1.33	25.00	6.67	1.17	38.00
	6	3.4	12.94	.29	—	.29	13.52	1.18	.88	10.00	2.90	—	14.96
	7	2	17.00	3.00	—	2.50	22.50	3.50	2.50	25.50	1.50	—	33.00
	8	.4	—	—	—	—	—	—	—	—	—	—No Record	
1935 Average			23.42	1.58	.59	1.74	27.33	2.99	1.78	17.44	2.87	.48	25.56
1936	1	21	44.19	2.14	2.38	3.33	52.04	5.28	2.24	28.57	5.28	—	41.37
	2	14	5.36	.57	—	.36	6.29	1.43	.57	6.00	.71	52.22	60.93
	3	10	31.40	.80	—	1.20	33.40	3.20	2.10	17.20	1.50	—	24.00
	4	9	38.22	6.22	—	1.57	46.01	4.00	2.22	10.56	1.57	6.67	25.02
	5	6	35.17	2.50	—	1.17	38.84	3.00	1.33	29.17	6.67	1.17	41.34
	6	3.4	—	—	—	—	—	.59	.88	10.00	2.94	—	14.41
	7	2	12.50	1.00	—	1.50	15.00	3.00	2.00	25.50	1.50	—	32.00
	8	.4	20.00	.50	—	2.50	23.00	7.50	10.00	6.86	2.57	—	26.93
1936 Average			23.35	1.72	.30	1.45	26.82	3.50	2.67	16.73	2.84	7.51	33.25
1937	1	21	51.19	2.38	.48	4.52	58.57	6.33	2.14	28.57	5.28	2.38	44.70
	2	14	9.14	.72	—	.50	10.36	1.28	.50	6.00	.71	—	8.49
	3	10	42.20	1.10	—	1.30	44.60	4.20	2.20	19.60	1.50	—	27.50
	4	9	26.33	4.22	—	1.00	31.55	3.22	1.56	10.56	1.57	23.11	40.02
	5	6	57.50	3.67	—	1.67	62.84	4.50	1.33	33.33	6.67	1.33	47.16
	6	3.4	65.00	1.47	—	.88	67.35	4.12	.88	10.00	2.94	—	17.94
	7	2	97.50	4.00	—	3.50	105.00	7.50	2.00	25.50	1.50	—	36.50
	8	1.4	65.71	3.57	—	2.86	72.14	7.86	2.86	17.14	6.43	—	34.29
1937 Average			51.82	2.64	.06	2.03	56.55	4.88	1.68	18.84	3.32	3.35	32.07
3-Year Average			33.28	2.00	.30	1.74	37.32	3.82	2.06	17.68	3.02	3.92	30.50
Per cent of H. & M. and of overhead costs			89	5	1	5	100	11	6	59	12	12	100
Per cent of total costs			33	2	*	2	37	4	2	16	4	4	30

*Less than one per cent.

growers, the percentages for each are shown in Table 5. The average proportions for each orchard are presented graphically in Fig. 1.

Total Costs per Acre and per Pound—The cherry production costs per acre included in Tables 3 and 4 are totaled in Table 6 to the nearest whole dollar.

The variations among the eight growers in the proportion of their total production costs included in each group of factors are presented in Fig. 1 according to the average profit per acre made by each grower for the three-year period.

In a general way, both Table 6 and Fig. 1 support the recognized principle that the producer with minimum cost for the variable agents is not necessarily the one with the maximum profit; in fact the grower with the lowest cost per acre lost money during this three-year period. The explanation of this situation is found in the greater yields obtained in the orchards on more suitable land and under better care. Although there is a definite limit beyond which further expenditure is not profitable in a particular case, it is also true that up to that particular point a greater expenditure for land, capital or labor will result in a greater return for each unit of expenditure.

As a possible aid to Michigan cherry growers, in general, in adjusting their expenditures a comparison of the costs per acre on the most profitable and least profitable of the orchards is presented in Table 7.

Table 7 also includes a comparison of the proportion of the total cost represented by each item between the two growers and with the average for the group of growers. The fundamental importance of high yields in obtaining a low unit cost of production is shown again by the last line of Table 7.

Cherry Production Cost and Price Relationships—The cost of red cherry production per acre and per pound for eight Michigan growers has been presented in the preceding pages, while the prices received by cherry growers of the state in recent years are shown in Table 8.

A consideration of the cost data presented in this study and of the prices recorded in Table 8 confirms Gardner's conclusions in his recent study of cherry yields:* "(1) Though many Montmorency orchards have been, are and undoubtedly will continue yielding a profit, there is a considerable percentage that have been and are financial liabilities and for which there is no prospect of ever being lifted above the submarginal class. Though, for some years to come, new plantings are not warranted on sites and soils of the type that could be classified as average for the Montmorency orchards of today, there is every reason to believe that the cherry enterprise will continue to be profitable on good soils, favorably located and under capable management." It seems at the present time that growers with a cost of 3 cents per pound or more are not reasonably sure of a profit and that new plantings should be undertaken only when a prospective cost of 2.5 cents or less per pound seems assured.

*Gardner, V. R. Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan. Mich. Agr. Exp. Sta. Spec. Bul. 275. 1936.

Table 5. Percentages of total cherry production costs represented by growing, harvesting and marketing, and overhead costs for eight Michigan orchards, 1935-37.

Grower Number	1935			1936			1937			Average		
	Growing	H. & M	Overhead	Growing	H. & M.	Overhead	Growing	H. & M.	Overhead	Growing	H. & M.	Overhead
1	30	44	26	36	36	28	40	34	26	35	38	27
2	57	15	28	20	8	71	48	30	22	42	18	40
3	33	39	28	34	38	28	35	31	34	34	36	30
4	43	25	32	33	45	22	31	30	39	36	33	31
5	17	50	33	22	39	39	20	46	34	20	45	35
6	27	34	39	40	—	60	16	66	18	28	33	39
7	46	22	32	50	16	34	23	57	20	40	32	28
8	No Record			39	28	33	42	39	19	40	32	28
Averages	35	33	32	34	26	40	31	44	25	33	37	30

Table 6. Total cherry production costs, income and profits per acre and per pound for eight Michigan orchards, 1935-1937.

Year	Grower Number	Yield per acre (lbs.)	Per Acre (dollars)			Per Pound (cents)		
			Cost (a)	Income (b)	Profit	Cost	Income (c)	Profit
1935	1	7,488	164	194	30	2.19	2.60	.41
	2	620	35	16	−19	5.68	2.66	− 3.02
	3	4,346	51	135	−84	1.75	2.00	.25
	4	1,857	67	56	−11	3.71	3.00	− .29
	5	7,184	115	256	141	1.60	2.40	.80
	6	1,191	40	36	− 4	3.33	3.00	− .33
	7	4,462	101	121	20	2.26	2.50	.24
	8	—	—	—	—	—	—	No Record
1935 Average		3,878	82	116	34	2.97	2.59	− .38
1936	1	4,670	146	168	22	3.14	3.60	.46
	2	716	82	24	−58	4.10	3.35	− .75
	3	4,234	88	190	102	2.07	3.40	1.33
	4	5,814	105	174	69	1.77	3.00	1.23
	5	4,689	102	215	113	2.18	3.00	.82
	6	70	25	—	−25	34.00	3.20	−30.80
	7	1,675	94	50	−44	5.64	3.00	− 2.64
	8	3,752	82	112	30	2.18	3.00	.82
1936 Average		3,194	91	117	26	3.01 (d)	3.65 (d)	.64 (d)
1937	1	4,619	171	188	17	3.71	4.05	.34
	2	1,222	35	32	− 3	2.85	2.66	− .19
	3	3,605	112	192	80	3.10	4.05	.95
	4	3,509	104	140	36	2.30	4.00	1.70
	5	7,662	137	346	209	1.79	3.82	2.03
	6	6,028	101	264	163	1.67	4.38	2.71
	7	13,000	189	550	361	1.45	4.25	2.80
	8	6,464	185	274	89	2.86	4.25	1.39
1937 Average		5,764	129	248	119	2.47	3.93	1.46
3-Year Average		4,296	101	162	61	2.79	3.27 (d)	.48 (d)

(a) From Tables 2 and 3 to the nearest dollar.
(b) Income from fruit only.
(c) Exclusion of grower whose abnormal costs per pound were the result of crop failure.
(d) Average omits extreme cost for grower number 6 in 1936, due to almost complete crop failure.

Table 7. Comparison of production costs on the most and least profitable of eight Michigan cherry orchards, per acre, for 1935 to 1937.

(dollars and cents)

Costs of Production	Most Profitable (No. 5) (a)				Least Profitable (No. 2) (a)				Comparative Percentages (b)		
	1935	1936	1937	Average	1935	1936	1937	Average	Average of eight	No. 5	No. 2
Labor—Pruning	1.00	1.17	2.00	1.39	1.14	—	—	.38	2	1	*
Fertilizing	.67	.83	1.00	.83	.07	—	.07	.05	1	*	*
Cultivating	2.67	2.83	3.50	3.00	.86	—	—	.29	1	2	*
Spraying	.50	.67	.67	.61	1.16	1.07	.93	1.05	1	*	1
Fertilizer and manure	2.67	3.33	4.17	3.39	.71	—	1.64	.78	8	3	1
Spraying equipment	.83	1.00	2.00	1.28	1.86	1.43	1.57	1.62	8	1	3
Use of equipment	6.33	6.83	7.67	6.94	12.14	11.87	11.43	11.78	7	6	26
Power and miscellaneous	5.34	5.67	6.00	5.67	1.78	.43	.36	.86	6	5	1
Total Growing Cost	20.01	22.33	27.01	23.11	19.72	14.71	16.00	16.81	34	20	36
Labor—Picking	53.83	35.17	57.50	48.83	4.64	5.36	9.14	6.38	31	41	12
Marketing	2.00	2.50	3.67	2.72	.36	.57	.72	.55	1	2	1
Truck and horse cost	1.00	1.17	1.67	1.28	.36	.36	.50	.41	1	1	1
Total harvesting and marketing cost	56.83	38.84	62.84	52.83	5.36	6.29	10.36	7.34	33	44	14
Share of general farm expenses	3.83	3.00	4.50	3.78	1.21	1.43	1.28	1.30	4	3	2
Taxes on orchard	1.33	1.33	1.33	1.33	.57	.57	.50	.55	2	1	*
Interest on value of trees	25.00	29.17	33.33	29.17	7.64	6.00	6.00	6.55	19	25	13
Interest on value of land	6.67	6.67	6.67	6.67	.71	.71	.71	.71	4	5	*
Depreciation of trees	1.17	1.17	1.33	1.22	—	52.22	—	17.41	4	1	34
Total overhead cost	38.00	41.34	47.16	42.17	10.13	60.93	8.49	26.52	33	36	50
Total production costs	114.84	102.51	137.01	118.11	35.21	81.93	34.85	50.67	100	100	100
Production per acre (pounds)	7,184	4,689	7,662	6,512	620	716	1,222	853			

(a) See Tables 1 and 2 for further data on these orchards, 1935-1937.
(b) To closest whole percentage.
* Indicate less than one per cent.

Table 8. Red cherry prices per pound received by Michigan growers, 1916-1937.

Year	Cents	Year	Cents	Year	Cents
1916	4.0	1925	5.0	1934	2.1
1917	5.0	1926	—	1935	2.6
1918	7.0	1927	8.5	1936	3.2
1919	11.0	1928	6.9	1937	3.9
1920	8.0	1929	7.7		
1921	10.5	1930	5.7	Average	
1922	6.0	1931	2.1	1916-37	5.4
1923	6.0	1932	1.4	1921-30	6.8
1924	5.0	1933	2.3	1931-37	2.5

Sources: 1916-25.....Mich. Agr. Exp. Sta. Bul. 166
1926.....Unavailable
1927-34.....Mich. Agr. Exp. Sta. Bul. 258
1935-37.....Average price received by eight growers reporting cherry costs in this study.

A QUICK METHOD OF PREDETERMINING THE CULINARY QUALITY OF POTATOES, WITH SPECIAL REFERENCE TO COLOR

E. J. WHEELER
Section of Farm Crops

Use of several varieties by growers producing Michigan's potato crop and the wide fluctuation in environment, soil, and production practices, make it difficult to standardize potato quality. Size and shape of tuber influence any study of quality, but far more important to the consumer is the production of potatoes which will be of good quality when cooked and ready to eat. One of the chief difficulties is to retain a definite white color of the potatoes after cooking, rather than shades of gray, brown or black. To date, the most widely used method for determining quality of a given lot of potatoes is to cook some of them. Because of the amount of work involved this method necessarily reduces the number of samples which can be tested. A quick test which would give some indication of cooking quality would be a great aid in evaluating new varieties and in determining the effect of various cultural practices on cooking quality.

While pickling some small sections of seedling potatoes of varied cooking quality for microscopic examination it was found that a solution of formalin alcohol brought about a decided difference in color and shrinkage of the small sections of tubers from the various lots. On further test, it was found that 95 per cent ethyl alcohol alone would show these differences and that these checked very closely with the results obtained from actual cooking tests. Three plugs were extracted from each of four tubers representing the sample to be tested by thrusting a three-eighths-inch by six-inch brass cylinder through the stem end, seed end, and middle portion of the potato.

One-half inch pieces were cut from the ends of each of the three plugs and placed in a one-inch by five-inch glass tube containing 95 per cent ethyl alcohol. The middle portions of the plugs were dis-

Table 1. A comparison of sections soaked in alcohol with their corresponding cooked potatoes.

	Tuber No.	Color of Alcohol Soaked Sections	Color of Cooked Potatoes Boiled
Sample No. 1 (Free from mechanical injury)	1	White	White
	2	White	White
	3	Gray	Gray
	4	White	White
Sample No. 2 (Severely bruised)	1	Dark	Very Dark
	2	Gray	Dark at Stem End
	3	Gray	Gray
	4	Slightly Dark	Dark

carded because it was found that they did not indicate the possible color of the cooked potato as well as the end pieces which included the skin and the growth ring area.

The plugs from each tuber were kept in separate glass tubes of the alcohol for one hour and then were examined for color and shrinkage. It was observed that tubers whose plugs or sections remained white and firm in the alcohol, cooked white, while those having shrunken and discolored plugs were usually gray or dark colored when boiled.

There was close correlation between color, texture and flavor. Potatoes that cooked white were usually mealy in texture and of good flavor, while those that discolored were often soggy and of poor flavor.

In testing potatoes for cooking quality it was necessary to compare the alcohol-soaked plugs with the cooked product. Four tubers were placed in a screen rack having four compartments. After a tuber was plugged it was peeled and placed in the No. 1 compartment, also the plugs from this same tuber were placed in No. 1 bottle. By keeping an accurate record of each tuber it was possible to obtain a comparison of the two quality testing methods. Several hundred tubers have been

Fig. 1. The potato on the left is one which cooked white and next to it is a test tube containing plugs from the same potato which have been soaked in 95 per cent ethyl alcohol for one hour. On the right is a potato which when cooked turned a dark gray color, and on the left of the tuber are shown the plugs from this tuber. Note shrinkage and color cast of the potato and plugs on the right as compared with those on the left.

tested and they compare very favorably, in that the tubers cooking dark will also have plugs that are dark in alcohol.

Ninety samples of table stock were tested at the Upper Peninsula Potato Show by both the alcohol and actual cooking tests. The time required for the alcohol test was 3 hours and for the cooking test by boiling 2 days. Results of the two tests were similar. In the alcohol 17 samples were white, 60 showed slight discoloration, while 13 were dark. In the cooking test 17 were white, 64 slightly gray and 9 were dark.

An accompanying table presents the comparative results between actual cooking and alcohol testing two samples of Russet Rurals. Sample 1 was selected from a lot of potatoes that was carefully harvested and stored and was free from mechanical injury. Sample 2 was taken from a lot of severely bruised stock that was carelessly handled. It will be noted that the color of the sections soaked in alcohol agree closely with the color of their corresponding cooked potatoes and that tubers in Sample 2 were discolored as a result of mechanical injury.

MICHIGAN FARM BUSINESS SUMMARY—1937

State Summary, Annual Farm Business Report, 1,163 Michigan Farms—1937

H. A. BERG AND C. O. MAY*

Nineteen thirty-seven was the ninth year of the Farm Management Extension Project in Michigan. This project, sponsored by the Farm Management Department of Michigan State College, was a part of the county agricultural agents' extension program in 76 counties.

During the spring of 1937 a total of 1,333 farmers had their farm accounts summarized. An annual farm business report was prepared for each type-of-farming area shown on the map (Fig. 1), with the exception of Area 10. Areas 1 and 6 were combined into one report. A total of 1,163 of the records were included in the area reports. It was necessary to exclude some records as they were on farms of an unusual type, or in some cases, the records were received too late. During the summer of 1938 an area report was returned to each individual. This report made possible a comparison of an individual farm with the average of other farms of a similar size and type, as well as a comparison with the more and less successful farms. It is through these comparisons that a farmer can determine the strong and weak points in his business. A study of these comparisons, in many instances, has aided farmers in making adjustments that have materially increased their incomes.

*E. B. Hill, J. C. Doneth, and L. H. Brown of the Farm Management Department, and the county agricultural agents in 76 counties assisted with this project.

Farm Earnings in 1937

Farm earnings on Michigan accounting farms were less in 1937 than in 1936. The earnings in 1937 were also less than in 1935, but were equal to those for 1934. The total cash receipts for 1937 averaged $3,358, or $5 more than for 1936. Cash farm expenses, on the other hand, averaged $232 a farm more in 1937. The greatest difference, however, was the fact that the inventory increase was only $155 a farm in 1937 while in 1936 the increase was $650 or a difference of $495. This increase in cash expenditures and the difference in inventory increases were largely responsible for the decline in farm earnings from

Fig. 1. Type of farming areas in Michigan

1. Dairying
2. Corn and Livestock
3. Small Grains and Livestock
4. Dairying and Poultry
5. General Farming
6. Dairying and Potatoes
7. Cattle, Beans and Hay
8. Beans, Beets and Dairying
9. Cattle, Sheep and Forage
10. Forage and Forestry

11A. and 11B. Potatoes and Cattle

12A. and 12B. Fruit

13. Cattle and Forage
14. Cattle, Forage and Potatoes

an average labor and management wage of $1,318 in 1936 to $569 in 1937.

An analysis of the increase of 1937 cash expenditures over those of 1936 shows that machinery increased $78, feed $53, crop expenses $46, hired labor $43, improvements $7, and miscellaneous $16. Livestock purchases were $11 less in 1937 than in 1936.

During 1937 cash expenditures for improvements and machinery continued to be more than sufficient to offset normal depreciation charges, causing a considerable increase in the inventory values. The inventory value of feeds and crops declined $175 from the beginning of 1937 to the end of the year. This decline was due largely to the drop in the price of grains, beans, and potatoes. The inventory value of livestock was slightly higher at the end of 1937, indicating more livestock on the farms, as the average price of meat animals had dropped approximately 13 per cent by the end of the year.

Some adverse weather conditions occurred in certain areas of Michigan during 1937, despite which most of the crop yields were close to normal. The yields of alfalfa hay, corn, and beans were above normal and decidedly above the 1936 yields. The 1937 wheat yield was below the 1936 yield, while the oat and barley yields were practically the same for both years. Sugar beet yields on accounting farms averaged 2.2 tons an acre less in 1937 than in 1936. The 1937 Michigan Crop Report indicated a near record production of apples, peaches and cherries, while that of plums, pears and grapes was about the average of past years.

There was a decided drop in grain prices during the last five months of 1937, but the average for the year was 17 per cent above the 1936 prices. This was a situation in which most of the purchased feed was bought at high prices during the first six or seven months of the year owing to the drouth in 1936. Following harvest there was not so much need for purchased grains, and grains marketed sold at greatly reduced prices.

The price of meat animals also declined at the end of 1937, but the average price for the year was the highest since 1930. While the average price of meat animals was 9 per cent higher, the average price of grains was 17 per cent higher in 1937 than in 1936, making the feeding ratio less favorable during 1937 than during the previous year. The rapid decline in meat animal prices at the close of the year worked a hardship on many feeders. Many lamb feeders filled their feed lots during the fall with high-priced feeders and were unable to sell at a price high enough to break even. Some cattle feeders who bought heavy, high-priced cattle in the early fall were forced to sell them at a loss.

Variation in Farm Earnings

Table 1 gives a five-year comparison of the financial returns from Michigan farms on which farm accounts have been kept. During 1937 operators of the 1,163 farms included in this report averaged $569 for their labor and management. This earning figure represents what the operator had left for his labor and management after paying all cash operating expenses, allowing for depreciation and other inventory losses, charging for family labor other than his own, and deducting 5 per cent interest on the total investment. This measure of earnings

Table 1. Five-year comparison of financial returns from Michigan farms, 1933-37.

Item	1933	1934	1935	1936	1937
Number of farms	795	845	933	1,055	1,163
Average investment	$11,820	$12,200	$12,510	$12,502	$12,904
Cash receipts	$1,825	$2,389	$2,826	$3,353	$3,358
Cash expenses	1,000	1,324	1,668	1,869	2,101
Net cash income	$825	$1,065	$1,158	$1,484	$1,257
Net change in inventory	153	252	398	650	155
FARM FAMILY INCOME	$978	$1,317	$1,556	$2,134	$1,412
Less: Unpaid family labor	138	142	166	191	198
NET FARM INCOME	$840	$1,175	$1,390	$1,943	$1,214
Less: Operator's labor	420	418	432	538	528
Return for investment and management	$420	$757	$958	$1,405	$686
RATE EARNED ON INVESTMENT	3.56%	6.21%	7.66%	11.24%	5.3%
NET FARM INCOME	$840	$1,175	$1,390	$1,943	$1,214
Less: Interest on investment @ 5%	591	610	626	625	645
OPERATOR'S LABOR AND MANAGEMENT WAGE	249	565	764	1,318	569

does not include any credit for the farm products retained for use by the family.

The accompanying graph (Fig. 2) shows the distribution of the incomes on the 1,163 farms on which records were kept during 1937,

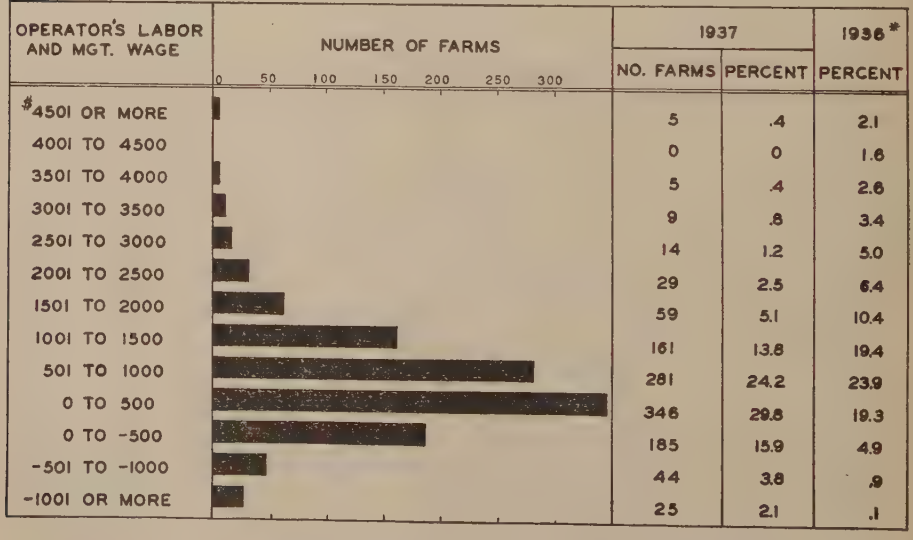

Fig. 2. Distribution of operator's labor and management wage, 1937.

*These percentages show the distribution of operator's labor and management wage of 1,055 farm account cooperators who had records summarized for 1936.

Table 2. Comparison of distribution of operator's labor and management wage, 1929-37.

Year	1929	1930	1931	1932	1933	1934	1935	1936	1937
Number of farms	427	771	925	831	795	845	933	1,055	1,163
Operator's labor and management	Percentage of farms in each income group								
$1,001 or more	25%	6%	1%	1%	10%	23%	31%	51%	24%
1 to 1,000	52	32	16	12	55	56	56	43	54
0 or less	23	62	83	87	35	21	13	6	22

while Table 2 gives a comparison of the earnings of farm account co-operators for each year 1929-37 inclusive.

Farm Investments

AVERAGE OF 1,163 FARMS

Land	$5,042
Buildings (less house)	3,315
Orchard	633
Livestock	1,675
Machinery	1,227
Feed	1,012
TOTAL INVESTMENTS	$12,904

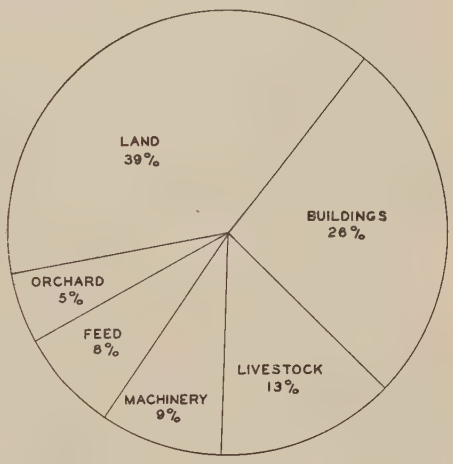

Fig. 3. Farm investments. Average of all farms in report.

Figure 3 indicates the average distribution of the capital invested in the 1,163 farm businesses represented in this report. The average size of these farms was 158 acres, of which 104 acres were tillable. The total inventory valuation of the real estate, livestock, machinery, and feed was $12,904. The real estate including land, orchard, and buildings (less house) composed 70 per cent of the total investment. This 70 per cent is more or less a fixed investment while the remaining 30 per cent is semi-fixed or operating.

Farm Receipts

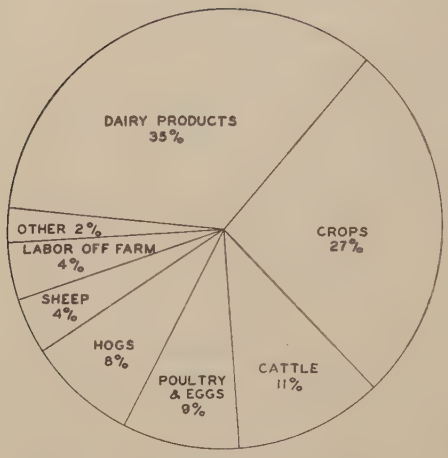

Fig. 4. Farm receipts. Average of all farms in report.

AVERAGE OF 1,163 FARMS

Crops	$730
Dairy products	974
Cattle	293
Poultry and eggs	256
Hogs	230
Sheep	114
Labor off farm	119
Other receipts	45
GROSS INCOME	$2,761

During 1937, 67 per cent of the receipts on these farms came from livestock, 27 per cent from the sale of crops, 4 per cent from labor off the farm, and 2 per cent from miscellaneous sources (Fig. 4). The percentage of the total income obtained from crops was 27 per cent in 1937 as compared with 37 per cent in 1936 when crop prices were relatively high.

Farm Expenses

AVERAGE OF 1,163 FARMS

Operator's labor	$528
Feed bought	313
Machinery	298
Hired labor	259
Crops	218
Family labor	198
Buildings	131
Taxes	71
Other	59
TOTAL EXPENSES	$2,075

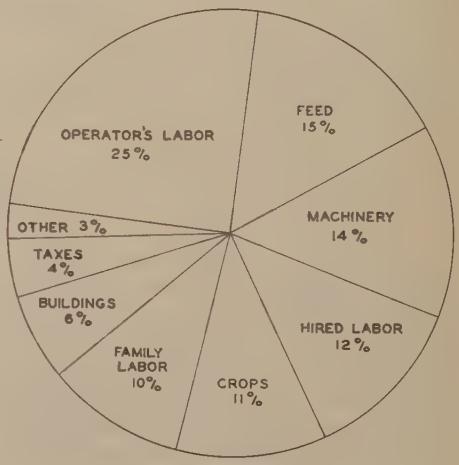

Fig. 5. Farm expenses. Average of all farms in report.

Figure 5 shows the relative importance of the expenses involved in operating a farm business. The figures shown for family labor and operator's labor were calculated at approximately hired wage rates, and do not represent actual cash expenses. The charges made for labor

Table 3. Acreages, investments, and financial summary on 1,163 Michigan farms by type-of-farming areas, 1937.

Type-of-Farming Areas	All Farms	2	3	4	5	6	7	8	9	11A	11B	12AN	12AS Gen.	Comm. Fruit	13	14	Chippewa Mackinac
Number of farms	1,163	89	86	45	173	63	30	119	55	89	42	46	64	124	41	77	20
Total acres	158	177	181	115	179	158	175	138	174	181	214	154	125	109	171	144	195
Per cent of land owned	80	76	72	79	72	70	91	78	78	87	80	93	77	86	94	96	88
Per cent of farm area tillable	66	73	75	76	71	73	81	75	54	53	56	60	69	71	48	37	66
Tillable acres	104	130	135	88	127	115	141	104	94	96	119	92	87	77	82	54	128
Capital Investments, Total	$12,904	$16,249	$14,777	$11,400	$15,882	$15,886	$15,104	$15,257	$9,431	$7,924	$11,881	$8,330	$9,770	$14,895	$7,408	$8,594	$10,798
Real estate (less house)	8,990	10,652	10,555	7,650	10,891	11,366	9,845	10,768	6,294	5,011	8,059	5,426	6,786	12,004	4,579	5,699	7,477
Machinery and equipment	1,227	1,351	1,189	1,010	1,350	1,248	1,544	1,399	979	941	1,064	1,070	886	1,439	963	1,338	1,236
Feed, crops and supplies	1,012	1,622	1,157	1,039	1,379	1,285	1,370	1,336	524	887	1,055	569	698	642	572	374	580
Livestock (includes horses)	1,675	2,624	1,876	1,701	2,262	1,987	2,345	1,754	1,634	1,085	1,703	1,265	1,400	810	1,294	1,183	1,505
Cash Receipts, Total	$3,358	$5,114	$3,622	$3,273	$3,995	$3,770	$4,195	$3,617	$2,117	$2,104	$2,889	$2,190	$2,603	$4,112	$1,861	$2,198	$2,938
Livestock sales, total	2,147	4,073	2,567	2,733	2,933	2,728	2,994	2,110	1,527	1,147	1,528	1,532	1,876	951	1,110	1,457	2,056
Crop sales	906	653	720	286	763	756	795	1,190	359	704	843	438	523	2,857	460	304	355
Labor off farm	119	92	129	85	101	94	133	119	112	103	76	76	97	124	174	223	306
Other receipts	186	296	206	169	198	192	273	198	119	150	142	144	107	180	117	214	221
Cash Expenses, Total	$2,101	$3,753	$2,375	$2,060	$2,354	$2,340	$2,471	$2,068	$1,248	$1,278	$1,628	$1,330	$1,496	$2,833	$1,059	$1,339	$1,616
Farm improvements	236	378	254	244	270	258	214	317	167	197	234	94	134	266	125	142	101
Machinery and equipment	624	879	622	473	661	788	991	693	466	460	524	420	467	712	434	517	617
Livestock purchases	321	1,085	397	267	469	319	440	266	189	133	251	203	162	136	153	72	197
Feed bought	313	650	479	602	345	286	273	192	141	187	194	212	342	243	97	323	293
Hired labor	259	349	232	193	226	280	157	228	96	111	173	199	158	779	97	96	194
Crop expense	218	238	231	153	235	228	247	243	104	126	137	121	137	507	91	112	114
Taxes	71	96	95	64	80	94	87	77	54	43	77	52	57	74	41	37	61
Other expenses	59	78	65	64	68	87	62	52	31	21	38	29	39	116	21	40	39
Net Change in Inventory	$155	$106	$357	$218	$53	$115	$388	$251	$281	—$104	— $53	— $22	$54	$511	$20	$18	$20
Improvements (includes orchard)	120	209	92	116	91	113	50	165	69	98	100	9	21	320	39	47	— 10
Machinery and equipment	177	268	166	111	203	289	384	202	161	127	162	68	127	173	114	91	136
Feed, crops, and supplies	—175	—442	22	—109	—258	—311	— 91	—140	33	—360	—358	—135	—140	5	—170	— 98	—168
Livestock (includes horses)	33	71	77	100	17	24	45	24	18	31	43	36	46	13	37	— 22	62
Net Cash Income	$1,257	$1,361	$1,247	$1,213	$1,641	$1,430	$1,724	$1,549	$869	$826	$1,261	$860	$1,107	$1,279	$802	$859	$1,322
Plus: Inventory Increase	155	106	357	218	53	115	388	251	281	—104	— 53	— 22	54	511	20	18	20
Farm Family Income	1,412	1,467	1,604	1,431	1,694	1,545	2,112	1,800	1,150	722	1,208	838	1,161	1,790	822	877	1,342
Less: Unpaid family labor	198	160	199	123	180	231	232	189	183	164	253	168	219	205	186	303	198
Net Farm Income	1,214	1,307	1,405	1,308	1,514	1,314	1,880	1,611	967	558	955	670	942	1,585	636	574	1,144
Less: Interest at 5%	645	812	739	570	794	794	755	763	472	396	594	417	488	745	370	430	540
Operator's Labor and Management Wage—1937	569	495	666	738	720	520	1,125	848	495	162	361	253	454	840	266	144	604
Operator's Labor and Management Wage—1936	$1,318	$1,777	$1,106	$1,138	$1,512	.....	$1,940	$1,899	$852	$945	$1,228	$770	$934	.....	$841	$620	$1,241
Operator's Labor and Management Wage—1935	764	1,566	751	644	1,007	.....	687	912	464	456	769	471	506	.....	—	428	633

Table 4. Percentage of land in different crops and crop yields by type-of-farming areas, 1937.

Type-of-Farming Areas	All Farms	2	3	4	5	6	7	8	9	11A	11B	12AN	12AS Gen.	Comm. Fruit	13	14	Chippewa Mackinac
Number of farms	1,163	89	86	45	173	63	30	119	55	89	42	46	64	124	41	77	20
Number tillable acres	104	130	135	88	127	115	141	104	94	96	119	92	87	77	82	54	128
Per cent tillable acres in hay, seed, and pasture	43	37	38	42	41	44	49	32	51	53	51	56	46	27	60	60	60
Per cent tillable acres in legumes*	28	28	24	23	27	31	29	26	32	26	30	36	30	27	40	31	11
Per cent tillable acres in:																	
Tillable pasture	17	15	17	15	19	19	24	12	17	21	23	25	16	9	12	11	15
Alfalfa hay	16	17	15	13	15	17	14	15	22	17	20	22	20	12	26	19	6
Other hay	9	5	5	14	6	8	9	3	11	15	7	9	9	5	16	30	38
Corn	15	24	20	22	17	16	10	15	13	13	12	13	15	11	8	7	0
Wheat	10	15	16	13	13	10	8	10	6	4	5	5	8	4	4	2	5
Oats (oats and barley mixed)	11	10	10	13	12	14	14	12	13	8	10	11	11	5	9	10	16
Barley	3	3	1	3	2	3	5	8	3	1	2	0	1	1	3	9	8
Beans	3	0	0	0	5	2	7	14	5	1	2	1	3	1	1	0	0
Sugar beets	1	1	0	0	1	0	3	5	0	0	0	0	0	0	0	0	0
Potatoes	2	1	1	1	1	3	0	1	1	7	7	4	4	2	6	6	1
Fruit and truck	4	1	1	1	1	2	0	1	1	1	1	3	5	40	1	1	1
Other crops	9	8	14	5	8	6	6	4	8	12	11	7	8	10	14	5	10
Crop Yields per Acre:																	
Alfalfa hay T.	1.7	2.0	1.6	1.7	2.1	2.0	2.1	2.1	1.6	1.1	1.4	1.4	1.8	1.6	1.4	1.4	1.2
Other hay T.	1.2	1.4	1.3	1.7	1.4	1.5	1.3	1.4	1.2	.8	1.1	1.0	1.2	1.4	.9	1.3	.8
Corn for silage T.	7.6	7.4	8.7	7.0	7.5	8.1	8.0	8.7	8.6	6.6	7.2	5.5	7.4	7.9	7.2	8.0	—
Corn (shelled) Bu.	36	40	35	36	37	34	38	42	34	26	36	30	32	32	31	38	—
Wheat Bu.	19	18	20	18	18	23	25	27	19	11	16	16	19	19	12	9	12
Oats Bu.	29	28	29	30	32	30	35	40	27	19	25	18	28	29	24	20	20
Barley Bu.	23	20	27	23	21	23	32	33	22	17	20	16	16	14	17	13	11
Beans Bu.	16	—	6	14	13	19	17	21	16	6	11	10	8	7	8	—	—
Sugar beets T.	8.2	7.1	—	8.8	6.4	—	7.4	9.0	—	—	—	—	—	—	—	—	—
Potatoes Bu.	125	69	115	88	79	100	137	148	110	145	138	132	105	112	131	161	165
Value crops produced per tillable acre	$14 77	$14.36	$13.98	$15 88	$13.88	$15 83	$14 45	$20 95	$13 64	$12.43	$13 54	$13 34	$15.65	—	$12.66	$15.77	$7.99
Crop sales	906	653	720	286	763	756	795	1,190	359	704	843	438	523	$2,857	460	304	355
Feed bought	313	650	479	602	345	286	273	192	141	187	194	212	342	243	97	323	293

*Tillable land in tree fruits and vineyards is not included in this factor.

Table 5. Livestock, kinds, amounts, and returns by type-of-farming areas, 1937.

Type-of-Farming Areas	All Farms	2	3	4	5	6	7	8	9	11A	11B	12AN	12AS Gen.	Comm. Fruit	13	14	Chippewa Mackinac
Number of farms	1,163	89	86	45	173	63	30	119	55	89	42	46	64	124	41	77	20
Livestock Income, Total	$1,867	$3,065	$2,249	$2,568	$2,482	$2,450	$2,592	$1,877	$1,347	$1,059	$1,650	$1,381	$1,767	$844	$988	$1,377	$1,906
Livestock income per tillable acre*	18.47	23.65	16.64	29.33	19.50	21.44	18.36	17.98	14.35	11.01	13.84	15.01	20.82	17.24	12.07	25.71	14.94
Productive animal units	20.2	32.5	24.4	20.7	26.5	21.1	26.4	19.6	20.2	14.6	21.3	18.0	18.1	8.8	17.3	14.6	16.9
Tillable acres per Productive animal unit*	5.0	4.0	5.5	4.2	4.8	5.4	5.3	5.3	4.6	6.6	5.6	5.1	4.7	5.5	4.7	3.7	7.5
Cattle:																	
Number of dairy cows	9.2	9.7	9.7	11.0	9.8	12.7	14.2	8.5	8.0	7.9	10.4	9.6	9.6	4.8	8.5	10.1	9.5
Dairy sales per cow	$106	$113	$112	$128	$119	$139	$115	$100	$72	$81	$84	$87	$101	$101	$63	$107	$130
Dairy sales, total	974	1,094	1,082	1,417	1,161	1,770	1,628	853	570	640	876	834	973	485	530	1,086	1,231
Cattle income, total	1,267	1,612	1,365	1,719	1,547	2,063	2,224	1,206	859	813	1,233	1,041	1,240	596	754	1,240	1,415
Poultry:																	
Number of hens	93	143	92	228	115	76	105	111	55	46	72	49	123	64	44	49	90
Egg production per hen	144	145	130	120	150	150	136	150	153	133	150	156	149	148	128	151	162
Egg sales per hen	$2.21	$2.26	$1.86	$2.67	$2.28	$2.26	$2.23	$2.23	$1.85	$1.60	$1.99	$1.73	$2.35	$2.03	$1.58	$2.46	$3.08
Egg sales, total	205	324	172	609	263	173	233	248	102	73	144	85	289	129	70	120	277
Poultry income, total	256	413	229	714	338	218	271	305	137	104	167	121	343	166	86	125	349
Sheep:																	
Number of ewes	10	17	12	2	24	5	4	8	24	4	10	6	1	1	11	0	6
Lambs raised per 100 ewes	103	104	103	114	100	117	110	95	107	111	114	107	113	103	97	—	93
Sheep income, total	$114	$334	$136	$23	$273	$44	$50	$75	$207	$37	$104	$63	$15	$8	$96	$3	$66
Hogs:																	
Number of sows	1.1	2.7	2.4	.4	1.4	.7	.1	1.4	.8	.8	.8	1.2	1.0	.4	.7	.2	.6
Number litters farrowed	1.7	4.3	4.0	.8	2.4	1.1	.2	2.2	1.2	1.0	1.3	1.7	1.4	.7	.8	.1	1.0
Pigs weaned per litter	6.6	6.5	6.7	6.2	6.5	6.8	7.8	6.5	7.4	6.9	7.4	6.5	6.4	6.3	7.4	7.5	8.6
Hog income, total	$230	$706	$519	$113	$325	$124	$47	$291	$144	$105	$146	$155	$169	$74	$52	$9	$76

*Tillable land in tree fruits and vineyards is not included in these factors.

Table 6. Labor, machinery, and improvement costs by type-of-farming areas, 1937.

Type-of-Farming Areas	All Farms	2	3	4	5	6	7	8	9	11A	11B	12AN	12AS Gen.	Comm. Fruit	13	14	Chippewa Mackinac
Number of farms	1,163	89	86	45	173	63	30	119	55	89	42	46	64	124	41	77	20
Man Labor:																	
Number of men	1.9	1.9	1.9	1.6	1.8	1.9	1.9	1.8	1.6	1.6	1.9	1.7	1.8	2.5	1.6	1.9	1.9
Man labor cost, total	$985	$1,062	$1,014	$881	$986	$1,069	$962	$977	$728	$732	$965	$811	$919	$1,491	$759	$859	$863
Hired labor	259	349	232	193	226	280	157	228	96	111	173	199	158	779	97	96	194
Charge for family help	198	160	199	123	180	231	232	189	183	164	253	168	219	205	186	303	198
Charge for operator's labor	528	553	583	565	580	558	573	560	449	457	539	444	542	507	476	460	471
Man labor cost per tillable acre	9.46	8.20	7.50	10.06	7.74	9.27	6.81	9.36	7.75	7.60	8.10	8.82	10.61	19.34	9.27	16.02	6.76
Power and Machinery:																	
Machinery cost: Total	$298	$362	$289	$236	$305	$335	$365	$329	$216	$217	$266	$249	$244	$396	$236	$281	$286
Per tillable acre	2.87	2.79	2.14	2.69	2.40	2.90	2.59	3.14	2.30	2.26	2.23	2.70	2.82	5.13	2.88	5.25	2.24
Per cent farms using tractors	58	65	59	51	62	65	70	74	42	43	52	48	44	65	39	62	60
Number of horses	2.8	3.1	3.4	3.0	3.2	3.2	3.2	2.8	2.8	2.4	3.0	2.5	2.7	2.1	2.6	1.6	2.7
Improvements:																	
Net annual cost: Total	$131	$168	$166	$123	$178	$146	$153	$149	$96	$92	$129	$82	$109	$110	$87	$89	$101
Per tillable acre	1.26	1.29	1.22	1.40	1.40	1.27	1.08	1.43	1.02	.95	1.08	.89	1.26	1.43	1.07	1.66	.79
Investment per animal unit	144	122	141	142	148	160	131	181	103	117	138	106	134	307	94	142	145
Feed bought per tillable acre	3.00	5.00	3.55	6.88	2.71	2.48	1.93	1.84	1.50	1.94	1.62	2.30	3.95	3.15	1.18	6.04	2.30
Crop expense per tillable acre	2.10	1.83	1.71	1.75	1.85	1.98	1.75	2.33	1.11	1.31	1.15	1.31	1.58	6.58	1.11	2.09	.89
Taxes per tillable acre	.68	.74	.70	.73	.63	.82	.62	.74	.58	.45	.64	.56	.66	.96	.50	.69	.48
Other expenses per tillable acre	.55	.59	.50	.76	.54	.85	.44	.57	.33	.37	.60	.51	.54	.76	.27	.98	.31
Gross income per tillable acre	$26.51	$26.24	$23.40	$32.75	$24.61	$26.13	$24.48	$29.48	$20.11	$15.93	$18.92	$19.54	$26.04	$51.34	$18.23	$34.86	$19.05
Total expenses per tillable acre	19.92	20.44	17.32	24.27	17.27	19.57	15.22	19.41	14.59	14.88	15.42	17.09	21.42	37.35	16.28	32.73	13.77
Net income per tillable acre	6.59	5.80	6.08	8.48	7.34	6.56	9.26	10.07	5.52	1.05	3.50	2.45	4.62	13.99	1.95	2.13	5.28
Expenses Per $100 Income	75	78	74	74	70	75	62	66	73	93	82	87	82	73	89	94	72

combined with the actual expenditure for hired labor accounts for 47 per cent of the total expenses. The figures are averages and of course much variation is found between individual farms.

State and Area Averages

The accompanying tables, 3, 4, 5 and 6, indicate that farm earnings in any one year vary considerably between different areas, and do not retain the same relative position in earnings year after year. (See bottom of Table 3.) Factors beyond a farmer's control, such as weather conditions and changes in the price level for the products produced, may cause changes in the relative position. These tables show percentages of tillable land in various crops, crop yields, livestock inventories, power and machinery costs, amounts of labor, and various factors affecting farm earnings, as well as average incomes and expenses.

SUPERB GOLDEN

A NEW HYBRID MUSKMELON

C. H. MAHONEY
Section of Horticulture

History of Superb Golden

The parents of Superb Golden were Emerald Gem and Honey Dew. Emerald Gem is a small, ribbed, dark green shelled, partially netted fruit with thick orange flesh. Honey Dew has medium-sized, non-ribbed (smooth), yellow-shelled, non-netted fruit with thick, crisp, green flesh. The original cross was made by George Starr of the Michigan Agricultural Experiment Station in 1930. The breeding work was undertaken by the author in 1931.

The fruits in the first generation either had dark green shells or greenish-yellow shells and all were ribbed; were fairly well covered with a fine net; and the majority of plants produced green-fleshed fruits. Some plants produced fruits with the placental region and the inner flesh showing a distinct "pink" or orange color with the outer one-half inch a light green. A number of the different F_1 types were selfed. With the exception of 1932 when open-pollinated fruits were selected, each generation has come from fruits self-pollinated by hand under glassine bags. Each year progenies of 25 to 30 hills were grown for field notes and observation and for further self-pollination.

Twenty per cent of the plants in the second generation produced yellow-shelled fruits which were ribbed, not netted or had slight flecks of net, and 1/7 of these had thick orange flesh, the remainder having thick green flesh. The yellow fruited plants were self-pollinated and in the following generation, plant selections having deep orange flesh and yellow shell were inbred. In the fourth generation the yellow shell and orange flesh characters were fairly uniform but the plants were still segregating for deep and shallow ribs. After two additional generations of selfing, six sib-progenies in the sixth generation were prac-

tically identical for such characters as shell color, flesh color, ribbing, size and shape of fruit, and thickness of flesh. Careful measurements were made of the size of fruit and thickness of flesh, and statistical analyses showed that these two characters were fairly uniform.

Description of Melon Type

The vine growth is extremely vigorous, leaves are large, and fruiting branches are heavy. Growth is more vigorous and heavy than that of Honey Rock, Hearts of Gold, or Honey Dew.

This is a mid-season variety which reaches picking stage about two to four days later than Honey Rock and in season with Hearts of Gold. This variety has a slightly higher heat-unit requirement than Honey Rock. When nights are cool during mid-summer this variety will mature 4 to 6 days later than Honey Rock but in Michigan during warm summers it reaches maturity at approximately the same time.

Statistical measurements and notes on three sixth generation sibs are given in Table 1 to illustrate the uniformity obtained with this new variety.

Table 1. Type measurements on three F_6 sib-progenies.

Prog. No.	Fruit Shape		Trans. Dia. Fruit		Flesh Thickness		Color of Flesh	
	Mode	Range	Mean	Range	Mean	Range	Mode	Range
307a.....	R	R	4.98	4.6 to 5.5	1.5	1.4 to 1.6	Deep Sal. orange	—
3076.....	R	R to OR	4.95	4.4 to 5.4	1.5	1.4 to 1.6	Deep Sal. orange	—
3077.....	R	R to OR	4.94	4.4 to 5.5	1.5	1.3 to 1.6	Deep Sal. orange	—

Fruit—Medium in size, 5 to 6 inches in transverse diameter. Shape round to slightly oblong-round not flattened at base and apex, blossom scar rather conspicuous; ribs moderately prominent 1¾-2 inches at medial; sutures narrow, shallow and an olive green until shortly before maturity, then turning yellow. Not netted; occasional flecks of cork scattered over ribs. Shell color greenish-yellow turning to brilliant yellow at maturity (Plate 19C-1*). Flesh deep salmon-orange, (Plate 10, D-7 to H-7*), very thick 1½-2 inches, texture fine to coarse, firm and moderately juicy; very sweet on after-ripening, total solids high; quality excellent. Cavity small 1¼-1¾ inches, circular. Rind thick and rather soft when fully matured.

Harvesting and Storage

This variety requires a short period of "after-ripening" before it reaches its maximum of quality. The fruits should be picked before the shell begins to soften or shortly after the "three-quarters slip."

*Maerz, A and M. R. Paul. Dictionary of Color. McGraw-Hill Book Co., New York, N. Y.

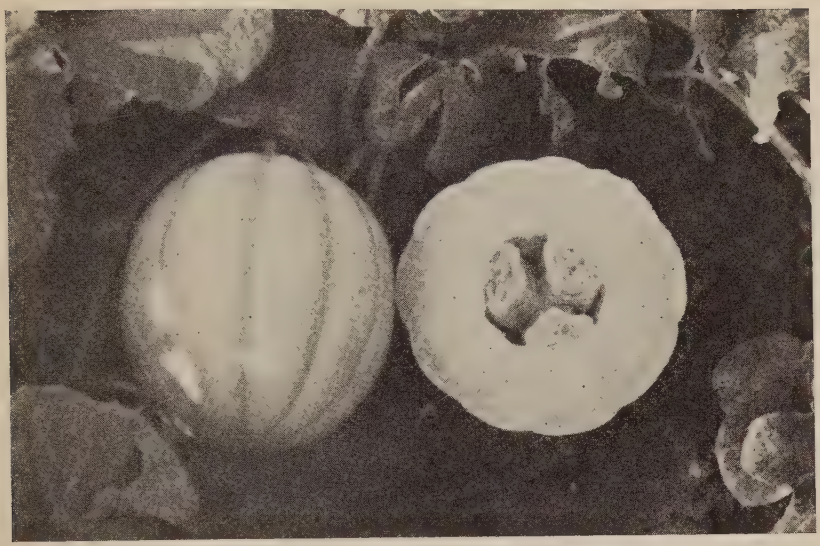

Fig. 1. Cross section and entire melon of Superb Golden.

There is a distinct change in color from a light greenish-yellow to a bright yellow and fruits should be picked at this time. They will crack badly if left in the field beyond this stage. The melons should be stored at a temperature of 70 to 75 degrees F. for several days to increase the sugar content and "blend" the aromatic cantaloupe flavor with that of the Honey Dew. **Fruit should not be marketed directly from the field; without this period of "after-ripening" the flesh is hard, dry, crisp, and lacks flavor.** This variety can be placed in cold storage for a period of a week to 10 days after receiving two days of "after-ripening" at 70 degrees F.

The introduction of this new variety is not for the purpose of replacing any of the standard commercial sorts such as Hearts of Gold or Honey Rock, but to supplement them with an early Honey Dew type which can be grown in the north. The dry, crisp, sweet flesh of the Honey Dew combined with the aromatic flavor of the muskmelon is far more attractive to the average northern consumer than that of the typical Honey Dew. The ribbed segregate was chosen by commercial growers as they felt that this yellow-ribbed type would be a trademark to distinguish this melon from the green-fleshed western Honey Dew. It should find a place in commercial production especially where the crop is marketed locally or from roadside stands.

Seed

Small samples of seed will be available this winter to **commercial cantaloupe seedsmen only** for increase in 1939. There will be no general release of seed, since the supply of hand pollinated seed is necessarily limited.

DISTRIBUTION OF FLAVORS IN MILK AT THE RECEIVING PLATFORM

G. M. TROUT
Section of Dairy Husbandry

Flavor studies were made on 920 cans of milk at the receiving platform of a local dairy during the late summer of 1937. In studying the flavor and odor of milk from the individual cans, two objectives were in mind: (1) to note the distribution of flavors in the raw product at that season and, (2) to note if all the milk of a single producer had the same flavor. Such information would be of material value in guiding the production of milk from the standpoint of flavor quality.

The data obtained were the basis in part of a discussion on off-flavors in raw and in pasteurized milk made at the Laboratory Section meetings of the Thirtieth Annual Convention of the International Association of Milk Dealers and are included in their Proceedings.* Sufficient interest was manifest that it seemed desirable to make the data more available to Michigan dairymen through the Quarterly Bulletin.

Table 1. The flavors of milk at the receiving platform as observed in individual cans.

Flavor	Number of Cans	Percentage distribution (%)
Clean, pleasant	413	44.89
Feed	219	23.80
Musty	101	10.97
High-acid	73	7.93
Unclean	58	6.30
Barny	13	1.41
Cowy	12	1.30
Oily	13	1.41
Miscellaneous	18	1.95
Totals	920	99.96

The nature of the flavors noted in these studies and their distribution are presented in Tables 1 and 2. As noted in Table 1, approximately 45 per cent of the cans of milk examined were classified as having a clean, pleasant flavor. The remaining 55 per cent of the cans of milk in which off-flavors were noted are reclassified and the distributions included in Table 2. Of the off-flavors noted, feed flavors were the most predominant, amounting to 23.8 per cent of all the samples and to 43.19 per cent of the off-flavored samples. Musty flavor was second to feedy flavor in occurrence, followed closely by high-acid flavors.

*Trout, G. M. Off-flavors in Raw and in Pasteurized Milk. Proc. 30th Ann. Conv. Int. Assn. Milk Dealers, Lab. Sect., p. 131-142, 1937.

Table 2. The flavors of milk at the receiving platform as observed in individual cans.

Flavor	Number of Cans	Percentage distribution (%)
Feed	219	43.19
Musty	101	19.92
High-acid	73	14.37
Unclean	58	11.44
Barny	13	2.56
Cowy	12	2.37
Oily	13	2.56
Miscellaneous	18	3.55
Totals	507	99.98

Considering the season of the year, late August, when much pasturing of alfalfa was practiced and when the nights were warm, it is not surprising to find such a high percentage of feed flavors and of high-acid flavors present. Other flavors such as unclean, "barny", "cowy", oily and miscellaneous were noted, but contributed only a small percentage to the off-flavored samples as a whole.

Examination of the milk from the individual cans rather than the mixed milk from the weigh tank gave a clue to the method of production not to be noted in the examination of the mixed milk as a whole. For example, in flavoring, by the individual can method, the milk of a four- to six-can producer, it was common to find half the cans severely criticised for off-flavors while the other half were free of undesirable flavors. This was particularly true of such flavors as feed and high-acid. The predominating feed flavor was from alfalfa pasturage. The lack of this flavor in some cans of a single producer yet present in others, was doubtless the result of management. The cows evidently were kept off the pasture several hours before milking in one case and milked immediately from pasture in the other case. Hence, the difference in flavor between the night's and morning's milk.

The same may be said of the high-acid milk as well. Inadequate cooling of the night's milk and prompt delivery of the morning's milk yielded half the cans with a high-acid flavor in the one half and the other half free of this flavor defect. Yet as a result of blending, the specific defect may not be noted in the mixed milk.

A significant observation was made on the "musty" flavor. When this flavor was encountered it usually was present throughout the entire lot of milk, rather than in a part of the cans. This defect is easy to recognize but extremely difficult to diagnose. It may be the result of inadequate or delayed cooling; to poorly washed cans; to uncleanliness or to a combination of those causes. Frequently this flavor in lesser intensity is called "smothered" which would seem to be questionable. In the more intense form the flavor is sometimes called "fishy", or "dishcloth".

The "barny" and "cowy" flavors, which are usually more common during the winter season than during the summer, are often difficult to distinguish from each other. The former seems to have an associated uncleanliness lacking in the latter.

The oily flavor found in these studies was suggestive of kerosene and of exhaust fumes, probably absorbed from the engine operating the milking machine.

The flavor of milk delivered at the receiving platform is not constant for each producer throughout the year but varies with the season, feed, temperature, and period of lactation. The examination of milk flavors at one season of the year may not be indicative of the flavors at other seasons. Likewise, the flavor of milk in the weigh tank may not be indicative of that of the several cans of a single producer which make up the whole.

Change in management of feeding practices together with adequate cooling would eliminate much of the feed, musty and high-acid flavors predominating the off-flavors at certain seasons of the year.

CONTROLLING INSECTS ON RASPBERRIES

RAY HUTSON
Section of Entomology

Raspberries are a popular and profitable small fruit affected by a number of insects well known to entomologists. However, the abundance and kinds of these pests vary so much from year to year that predictions are difficult, and control measures commonly employed require revision to harmonize with present knowledge and regulations. As an example of the necessity for revision, the outbreak of raspberry sawflies last spring found many growers using arsenicals on raspberries with a crop already set. The danger of residues can be avoided by use of present knowledge; in controlling sawflies, rotenone-containing and pyrethrum insecticides seem more effective than arsenicals.

For convenience of discussion, the insects infesting raspberries may be divided into those affecting the foliage, the cane and the fruit.

Insects Affecting the Canes

The most important insects infesting the canes are the red-necked cane-borer, *Agrilus ruficollis;* raspberry cane girdler, *Obcrea bimaculata,* and rose

Fig. 1. Raspberry canes infested by cane borers often break over at the point girdled by the larvae.

Fig. 2. Injury inflicted at egg laying and adult Raspberry cane borer.

girdler, *Agrilus communis* var. *rubicola.* The crown borer, *Bembecia marginata,* and tree crickets, *Oecanthus,* sometimes cause difficulty in plantings of raspberries, but ordinarily in well-cared-for plantings pruning takes care of the tree crickets while, as yet, the crown borer is very largely a curiosity in Michigan plantings. All of these insects in the adult stage are rather inconspicuous, but individuals are capable of doing damage out of proportion to their size by depositing eggs. For that reason, no great amount of space needs to be spent on the appearance of the adult insects. Injury by the red-necked cane borer and by the rose cane borer results in the formation of swollen areas about the canes, usually within one foot of the ground. These swellings are caused by the activity of the larvae of these borers, which are small, worm-like inconspicuous forms, deriving their food from the cambium or growing layer of the cane. Very commonly, activities of these larvae bring about a weakening of the canes at the point where the gall is formed with the result that large numbers of canes break over. These same swellings can be observed on dewberries, blackberries, and on rose-bushes. In case the canes do not break over, they are weakened and may die and, in any case, will not bear a normal crop. The only habit of the adult beetles that needs to be noticed is that they feed upon the foliage of the raspberries prior to depositing the eggs, eating holes and giving the leaves a generally ragged appearance. It is doubtful whether the feeding by the adults on the leaves is of any particular consequence, although in heavy infestations, this habit affords an additional means of combating the insects since an application of arsenical applied just prior to blooming aids in control. Ordinarily this method does not need to be used and is mentioned solely for use in case of heavy infestations.

Tree crickets, while not so destructive as the cane borers, may under local conditions build up to a point where they are capable of causing considerable loss. This is especially true under conditions where heavy pruning is not regularly done. Tree cricket adults, as their name indicates, somewhat resemble crickets in form of the body. However, they are of a yellowish or greenish-white color and are often noticed by growers. The damage by tree crickets consists in the deposition

of eggs in long rows in the canes while they are young and succulent. Later, when the canes ripen, this causes them to split and break over. Ordinarily the pruning operations followed in a planting of raspberries take care of this insect inasmuch as it has but a one-year cycle. Little trouble is experienced in Michigan since the regular pruning practice largely controls the insect.

Crown borer, fortunately, has not caused any large loss of Michigan raspberries in recent years. This insect is the larva of a moth which deposits its eggs near the ground level sometime during late August and September. The immature stages of the insects are completed within the cane at the ground level and the adult emerges again the following summer. No control measures have as yet been necessary for this insect in this state and it is included in this discussion solely for the sake of completeness.

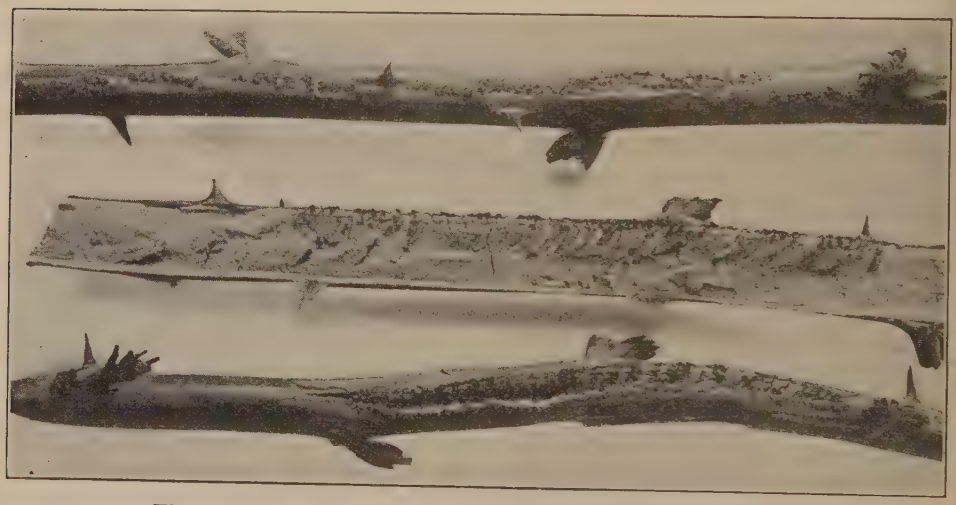

Fig. 3. Tree cricket eggs cause the canes to split or break.

Insects Affecting Foliage

A great many foliage-feeding insects, such as caterpillars, may be found upon the foliage of raspberry; however, most of them will succumb to the treatment that is applied for sawfly, which is the most important foliage-feeding pest of the raspberry. As in the case of the insects infesting the canes, the sawfly adults are not very conspicuous but belong to the same general group as wasps and are probably mistaken for them when seen by the grower. The larvae, however, are small, worm-like insects, mossy green in color, which are familiar to every raspberry grower. There is commonly one generation and sometimes two in a season. The feeding of these larvae gives the foliage a ragged, shot-holed effect, and when the larvae become numerous and are allowed to feed undisturbed the foliage may be entirely destroyed. The attack of sawflies, coming as it does commonly about the time that the berries are ripening, has a most adverse effect upon

the crop. There seems to be little chance of predicting when they will appear in any given locality; consequently, treatment for the insects should be deferred until they are seen at work. Sawflies are readily controlled by rotenone-containing or pyrethrum sprays and dusts. There are a number of good materials on the market, and the manufacture of these materials has become so standardized that purchase of a ready made dust is the best way to obtain the materials. The application of about 15 pounds of a dust containing ¾ of 1 per cent rotenone has given very good control against this insect. Equally good results have been obtained by applications of 15 pounds of a pyrethrum dust containing approximately 0.2 of 1 per cent pyrethrins. The only caution that needs to be emphasized is that sulphur should not be used as a diluent for dusts applied to raspberries. Equally good results in the control of these insects have been obtained by the use of sprays of derris and pyrethrum, although it seems that dusts of these materials are more available than sprays in many raspberry-growing districts. Should the insects appear prior to fruit setting, arsenical sprays or dusts may be used.

Fig. 4. Raspberry leaves skeletonized by sawfly.

Mites often cause much difficulty by feeding upon the foliage of raspberries. Mite feeding consists in the withdrawal of sap from the leaves with the result that they attain a scorched appearance and then, if the population of mites continues to increase, the leaves fall off. Mite attack is very severe since the period of greatest abundance of mites seems to come just at the time when the berries are ripening. In cases where mites become very abundant, plants attacked by them may present a scorched appearance and crop loss result. Mites are not insects but are closely related to them. The particular mites that are most commonly found on raspberries seemingly over-winter upon the canes. Hence, a dormant spray of liquid lime-sulphur or of 2-per cent oil constitutes a very good means of fighting them. In applying dormant sprays for mites, care should be taken to make sure that the sprays are applied during the time when the canes are completely dormant, else injury may result, especially to red raspberries. Many growers prefer to wait until the leaves are out and then fight the mites. A large amount of spraying has been done in this connection, and it seems that the best spray for combating mites is a 1-per

cent oil spray applied at the rate of about one gallon per rod of row and repeated three times at weekly intervals. This spray can be put on at any time and constitutes an excellent means of control without danger of residue. During the last two years success in the control of mites on raspberries has followed the use of a spray of bill-poster's paste at the rate of 5 pounds in 100 gallons of water. Here, again, the spray must be repeated and here, also, there is no danger of residue.

Raspberry fruit worm, *Byturus unicolor,* is an occasional pest of raspberries which at times becomes very numerous. The adult is a small brown beetle which appears about the time that the raspberry fruit buds appear and feeds upon the leaves. It is the habit of the adult beetle to deposit the egg in the bud of the raspberry where it grows and comes to maturity about the time the raspberries are picked with the result that the fruits are "wormy." As already noted, the adult insect feeds upon the foliage of the plant, hence, an application of a dust or spray to the foliage prior to the time when the blooms appear will result in control of this insect. Very good results have attended the use of calcium arsenate dust made up in the proportions of one part of the arsenate to nine parts of lime. If the presence of these insects is not noted in the planting until the plants are in bloom, or nearly so, the insect may be controlled through the use of a derris dust, such as has been described for use against sawfly.

As has already been indicated, the insects discussed are not all of those which may be found from time to time on raspberries. However, these are the most important and their control can be stated in the form of an insect control summary for raspberries with the assurance that with very slight modifications the summary will fit conditions anywhere in the state.

The foregoing summary is submitted as a reminder. Many growers

SUMMARY OF INSECT CONTROL ON RASPBERRIES

Treatment	Method or Material	Insect Controlled
Dormant	Prune and burn all malformed and old canes.	Red-necked cane borer. Raspberry cane girdler tree crickets.
	Liquid lime-sulphur, 10 gallons in 100; or 2% dormant oil.	Mites.
Just after leaves appear	1% summer oil—repeat three times at three-day intervals.	Mites.
Just before bloom	Lead arsenate 3 pounds; in 100 gallons, or calcium arsenate—Lime 1–10.	Sawflies and leaf feeders. American Raspberry beetle.
After fruit is set	Always use non-arsenical sprays or dusts.	Mites—1% summer oil. Sawflies and other leaf feeding insects.

need make only a few of these applications, the chief thing being to remember that all of these insects have a tendency to appear year after year in the same plantings after they are once established unless something is done.

Another point readily apparent is that applications prior to fruit setting take care of true insects affecting foliage and aid in controlling cane borers. In fact, an application of arsenical just prior to blooming is the most important spray for all chewing insects.

BULLETIN REVIEWS

Cir. Bul. 166—Water Conditioning for Greenhouses.—Spurway, C. H. and Wildon, C. E.—Description and explanation is given of a device that is connected with the water main and through which all of the water flows that neutralizes the alkalinity of "hard" water with phosphoric acid. It can be adjusted to deliver water of various degrees of alkalinity or acidity. Data are given on the influence of "conditioned" as compared with "hard" water on certain greenhouse crops. (10 pp., 1 table, 2 figs.)

Cir. Bul. 167—Controlling Rats and House Mice.—Hayne, D. W. and Jefferson, C. H.—A discussion of different methods of combating rats and mice about buildings. Part I contains an account of the history and habits of rats and the types of damage done, as well as an explanation of the various recommended control measures, which are: preventing rats from obtaining food, poisoning, fumigation, blocking, trapping, and other methods. Part II is devoted to the only permanent solution, rat-proof construction. (32 pp., 14 figs.)

Spec. Bul. 294—Profitable Poultry Production.—Wright, K. T.—Flocks in this cost of production study had an average production of 114 eggs per hen based on the number of birds at the start of the year, or 157 eggs based on the average number of hens. Of 100 birds at the start, 19 died, 42 were culled out and 39 were left, resulting in an average of 73 birds for the year.

Feed consumption averaged 40 pounds of mash and 39 pounds of scratch per hen for the year, valued at 52 per cent of the $2.34 total cost per hen for the year. Depreciation comprised 18 per cent of the total cost, labor made up 13 per cent, buildings and equipment use 7 per cent and other items 10 per cent. Income totaled $2.66 a hen, leaving a net return of 32 cents. The return to these better-than-average poultrymen was 37 cents an hour, or approximately twice the rate paid hired help.

The most important factors affecting net returns were: (1) eggs laid per hen, (2) fall egg production, (3) feeding efficiency, (4) death loss and culling percentage, and (5) labor efficiency. The men scoring the lowest on these factors lost 21 cents a hen, while those ranking the highest made a net return of 86 cents a hen.

To feed the broilers and pullets of 100 baby chicks required 703 pounds of mash and 318 pounds of scratch, which had a value of $18.08 during the period of this study. The cost of the chicks, feed, labor and all other items totaled $38.41 on 100 chicks. Income, other than pullets, amounted to $16.02, leaving a net cost of $22.39 for the pullets, or 58 cents each. Feed consumption averaged 4.9 pounds per pound of poultry produced, thus 1.8 pound broilers ate 8.9 pounds of feed, and 3.5 pound pullets 17.0 pounds of mash and scratch.

Feeding efficiency of the poultrymen and breed of poultry were important factors influencing pullet cost. Mortality in raising the chicks

had more effect on the laying flock returns than pullet cost, within reasonable limits. Hatching date of the chicks likewise had more influence on profits of the laying flock than on pullet cost. Thus, low mortality in the chicks was necessary for profits on the hens, and the slight increase in the net cost of early pullets was more than balanced by the higher egg income. (52 pp., 34 tables, 18 figs.)

Spec. Bul. 295—The Michelite Bean.—Thayer, J. W. and Down, E. E. —Michelite is the name given to a new variety of white navy bean developed by the Michigan Agricultural Experiment Station and first released to Michigan farmers for commercial production in 1937. The Michelite bean is a segregate selected from a cross between Early Prolific, a white bean of unusually good quality, and Robust, a high-yielding, disease-resistant, white navy bean previously developed at this station and, at present, the most commonly grown bean variety in Michigan.

Under Michigan conditions, the Michelite bean carries the resistance to mosaic, resistance to field infection of bacterial blight or wilt, and the vigor and productivity of its Robust parent. It is an improvement over the Robust bean in quality because of its uniformity in size and shape and its glossy white seed coat, characteristics inherited from the Early Prolific variety. It blooms from two to four days earlier but frequently ripens no earlier than does Robust. Because the Michelite bean generally has a lower percentage of culls than the Robust and, consequently, a higher percentage of marketable beans, because it yields as well as Robust and is superior in quality and appearance, this new variety should prove profitable for the Michigan bean industry. (23 pp., 8 tables, 6 figs.)

Spec. Bul. 296—Fertilizers for White Pea Beans.—Millar, C. E., Cook, R. L., and Davis, J. F.—Fertilizer experiments with white pea beans were conducted each year from 1923 to 1937 inclusive and on two farms in 1921. During this period experiments were located on 57 farms in 18 counties, and on 10 different soil series. The results of these experiments as presented in the bulletin lead to the following conclusions:

1. Broadcast application of fertilizer resulted in no increases in yield or in increases which, in most cases, were too small to pay for the fertilizer applied.

2. Seventy-five pounds of fertilizer applied with the seed failed to increase yields and furthermore decreased stand.

3. Three hundred pounds of 4-16-4 fertilizer in bands near the seed, but not in contact with it, caused significant increases in yield which in many cases were sufficient to more than pay for the fertilizer.

4. The advantages of fertilization may be nullified by adverse weather conditions especially at blossom time, even though early growth has been increased.

5. Fertilizer placed in a band about 1½ inches below the seed, or in bands 1½ inches to the side and deeper than the seed gave better results than other placements tried. A band of fertilizer on one side of the seed was as satisfactory as bands on both sides.

6. As a whole, a 0-16-8 fertilizer gave better results both from the standpoint of yield and economy than did 0-16-0 or 4-16-8.

7. Increases in yield resulting from application of fertilizer were not as consistent or as great as could be desired, largely because of the sensitivity of the crop to adverse weather conditions. The results of the work indicate that building up of the soil with manure, green manure, and fertilizer in the years preceding the planting of beans may be more advantageous than applying fertilizer at the time of planting the crop. (45 pp., 27 tables, 9 figs.)

Tech. Bul. 161—Studies in the Nature of the Pomological Variety. I. A Hetero-chimeric Apple Sport and Its Vegetative Progeny.—Gardner, V. R.—An historical and descriptive account is given of an unusual apple tree sport that is classified as a periclinal chimera, from which a number of distinct types have been segregated. Certain resemblances between this sport and a number of standard pomological varieties are pointed out. (14 pp., 2 tables, 4 plates.)

JOURNAL ARTICLE ABSTRACTS

Taxonomic Notes on the Dipterous Family Chloropidae.—Sabrosky, Curtis W.—Jour. New York Entomological Society. 46(4) :417-434. 1938. (Journal Article No. 293 (n.s.) from the Mich. Agr. Exp. Sta.)—Certain miscellaneous notes accumulated during the study of the classification of this group of small flies have been collected and published under the above title. Two new species are described, two new names are proposed, five new synonyms are established, and keys are given for the separation of species of two distinct groups within the family.

Quantity and Relationships of Certain Elements in Michigan Legume Hays.—Millar, C. E.—Jour. Am. Soc. Agron. 30(6) :507-513. 1938. (Journal Article No. 301, (n.s.) from the Mich. Agr. Exp. Sta.)—Samples of alfalfa, clover and sweet clover were collected from plats variously fertilized on different soil types during a period of 13 years. A study of the data derived from analyzing the samples lead to the following observations:

1. The nitrogen and phosphorus contents of the plants correlated closely.

2. Nitrogen-potassium, potassium-phosphorus, magnesium-phosphorus, and magnesium-nitrogen contents showed positive relationships.

3. Calcium-phosphorus, nitrogen-calcium, calcium-magnesium and calcium-potassium contents showed inverse relationships.

4. The phosphorus content of alfalfa grown on heavy soil types was higher than that of alfalfa grown on light soils. Applications of superphosphate under field conditions did not increase the phosphorus content of the hay, although there was a slight tendency for the phosphorus content of the leaves of alfalfa grown on sandy soils to be increased. Under greenhouse conditions, the phosphorus content of alfalfa was appreciably increased through very large applications of superphosphate.

5. Under field conditions applications of limestone reduced the phosphorus content of alfalfa, and applications of potash tended to increase it.

6. Applications of superphosphate increased the phosphorus content of field-grown red clover and sweet clover.

A Comparative Study of Methods of Determining the Moisture Content of Cheddar Cheese. II. The Steam Oven Method at High Pressure and the Olive Oil Methods.—(Gould, I. A.—Jour. Dairy Sci 21 (7) :379-383. 1938. (Journal Article No. 308 (n.s.) from the Mich. Agr. Exp. Sta.) —Analysis of cheddar cheese was made by the steam pressure oven operated at approximately 85 pounds pressure, the olive oil method in which the cheese was suspended in olive oil and dried directly over a flame, and the modified olive oil method which consisted in adding salt to the olive oil prior to the heat treatment to prevent sticking and spattering of the cheese during heating. Twenty-eight of 31 trials gave higher results by the steam oven than by the olive oil procedure, with the average difference being approximately 0.3 per cent. The

average difference between duplicate determinations by the oven method averaged 0.19±.02 per cent. The modified oil method gave results averaging within 0.1 per cent of those secured by the oven procedure. In general, the oil methods appear to be sufficiently accurate for all practical purposes and possess the distinct advantage of being more rapid than the oven procedure.

Cardiovascular and Other Lesions in Calves Fed Diets Low in Magnesium.—Moore, L. A., Hallman, E. T. and Sholl, L. B.—Archives of Pathology. 26:820-838. 1938. (Journal Article No. 314 (n.s.) from the Mich. Agr. Exp. Sta.)—Calves fed rations low in magnesium to the extent that the blood magnesium was reduced to a low level exhibited a definite pathologic picture. The principal pathologic alteration consisted of a deposition of calcium salts in the yellow elastic fibers of the endocardium, of the aorta, jugular vein and larger arteries, of the surfaces of the diaphragm and of the trabeculae and capsule of the spleen. Also notable were degeneration and calcification of Purkinje fibers. There were present also various degrees of hepatitis and nephritis. A possible relationship of diets low in magnesium to the arteriosclerosis of human beings is suggested.

Comparative Tests of Fixed Nicotines and Lead Arsenate Against Codling Moth.—Hutson, R., Merritt, J. M. and Parmelee, F.—Jour. Econ. Entom. 31(3):374-377. 1938. (Journal Article No. 318 (n.s.) from the Mich. Agr. Exp. Sta.)—Fixed nicotines and combinations of fixed nicotines with other materials tested in replicated plots of McIntosh, Duchess, Northern Spy and Baldwin apples in 1936 and 1937 gave control under conditions of heavy infestation, (50 to 200 worms per 100 apples in unsprayed plots), which compared favorably with applications of lead arsenate, 3 pounds to 100 gallons, applied as a check. The fixed nicotines are increased in effectiveness by the inclusion of oils. This is especially true in the combination of Black Leaf 155 plus 2 quarts of summer oil emulsion. In addition to the control secured, observations upon the tolerance of apple trees to the fixed nicotines showed them to be remarkably free from injurious effects.

A Field Outfit for Determining the Moisture Content of Soils.—Bouyoucos, G. J.—Soil Science. 46:107-112. 1938. (Journal Article No. 321 (n.s.) from the Mich. Agr. Exp. Sta.)—An outfit is described which can easily be carried into the field for the accurate and rapid determination of the moisture content of soils by means of the alcohol method.

Studies on the Composition of Bovine Blood. I. The Magnesium Content of the Blood Plasma of the Normal Dairy Calf.—Duncan, C. W., Lightfoot, C. C., and Huffman, C. F.—Jour. Dairy Sci., 21(11):689-696. 1938. (Journal Article No. 322 (n.s.) from the Mich. Agr. Exp. Sta.)—In order to establish certain basic facts concerning the amounts of magnesium in the blood plasma of growing dairy calves, 2,286 values were obtained from 107 normal calves at intervals of one or two weeks for a period of three years. Mean values were calculated for each month for the first 18 months of life. There was a definite tendency for the concentration of magnesium to increase up to 12-13 months and

the change in level was accompanied by a series of rhythmic variations. The mean of all of the determinations was 2.414±.005 mg. per 100 cc. of blood plasma (range 1.62 to 3.83 mg.) and 79.7 per cent of the values were between 1.895 and 2.795 mg. Seventy-two and one-half per cent of all the values occurred within the limits of plus or minus one standard error of prediction ($O_e = \pm 0.374$).

From the results obtained from this investigation it must be concluded that the concentration of magnesium in the growing dairy calf cannot be regarded as constant. The range of the so-called normal variation is sufficiently wide to include many variations that occur under pathological conditions since the maximum and minimum values for each month were definitely outside of the limits of plus or minus one standard error of prediction. The results also make it evident that fluctuations in the plasma magnesium content of the blood of dairy calves are to be expected as normal occurrences.

A Mechanical Device for Determining the Permanent Wilting Point of Soils by Means of the Cohesion Method.—Bouyoucos, G. J.—Soil Science. 46:331-336. 1938. (Journal Article No. 324 (n.s.) of the Michigan Agricultural Experiment Station)—An automatic device is described which increases the convenience, accuracy, and reliability of the cohesion method for determining the wilting point of soils.

The Effect of Fertilizer on the Length of Winter Wheat Heads.—Cook, R. L. and Baten, W. D.—Jour. Amer. Soc. Agron. 30:735-742. 1938. (Journal Article No. 328 (n.s.) of the Mich. Agr. Exp. Sta.)—The effect of fertilizers on the length of winter wheat heads was determined by measuring large numbers of heads taken from field plats in 1935, 1936, and 1937. The significance of mean differences is shown by analysis of variance. The use of Shepherd's correction for grouped data is illustrated. A statistical study of the number of heads necessary to make a representative sample is included.

The unfertilized wheat produced larger heads in 1935 and shorter heads in 1936 than did the fertilized wheat. During both years, fertilizers greatly increased the number of heads per foot of row. As the stand of the unfertilized wheat was much thinner in 1936 than in 1935 it is concluded that when crowding is not a factor, fertilizers may be expected to increase the length of heads but when the stand is so thick that the greater number of heads as a result of the fertilizer causes crowding, the length of the heads may be decreased. Some fertilizers resulted in larger heads than did other fertilizers.

The use of Shepherd's correction for grouped data did not change the interpretation placed on results.

The data obtained from the measurements showed that 100 heads picked at random did not truly represent the entire population but that it was necessary to measure 700 heads to obtain significant differences which were approximately the same as when all the heads were measured. The number "700" was theoretically checked by calculating "N" from the formula for "T".

Quantitative Studies of Brucella Precipitin Systems. I. Precipitation of Homologous Antisera by Brucella Endoantigens.—Pennell, R. B. and Huddleson, I. F.—Jour. Exp. Medicine. 68(1):73-81. 1938. (Journal Article No. 329 (n.s.) from the Mich. Agr. Exp. Sta.)—It has been shown

that the precipitation by the endoantigens of the three species of *Brucella* of their homologous antibodies may be described by equations developed from the law of mass action. The endoantigens may be used for the accurate calibration of *Brucella* antisera. The nitrogen-containing constituent of the endoantigens does not always seem to be intimately connected with the ability to precipitate the specific anti-bodies.

Quantitative Studies of Brucella Precipitin Systems. II. The Precipitation of Heterologous Antisera by Brucella Endoantigens.— Pennell, R. B. and Huddleson, I. F.—Jour. Exp. Medicine. 68(1):83-93. 1938. (Journal Article No. 330 (n.s.) from the Mich. Agr. Exp. Sta.)—Quantitative cross precipitation studies with goat antisera show the three endoantigens of the *Brucella* to be serologically distinguishable. Although the endoantigens of *Br. abortus* and *Br. suis* are very similar, they do not react identically, permitting the serological distinction of the two organisms. These differences in cross precipitation may be used to identify an organism of the *Brucella* group or to determine the organism responsible for a *Brucella* antiserum.

The Relation Between the Presence of Brucella Abortus and Agglutinins in Milk in Cattle Showing a Blood Agglutination Titer of 1-200 or Higher.—Myer, D. B. and Huddleson, I. F.—Cornell Veterinarian. 28(4):293-295. 1938. (Journal Article No. 332 (n.s.) from the Mich. Agr. Exp. Sta.)—In the majority of the animals studied *Br. abortus* appears in the milk before agglutinins are detected in the milk. *Br. abortus* may be present in the udder for a long period without the presence of agglutinins. *Br. abortus* and agglutinins may occasionally be present in the udder in the absence of agglutinins in the blood. Approximately 12 per cent of animals showing agglutinins in the milk in a titer of 1:100 or higher and positive milk culture become negative to the former or the latter or to both. These data show that often times there is little, if any, correlation between the presence of *Brucella* in the milk and the presence of agglutinins in the milk.

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